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ABSTRACT

Through 12 readings and 32 activities this curriculum material introduces high school students to issues of the global environment and society, while both challenging them to critically evaluate the issues and motivating them to develop solutions. The materials are cited as being applicable to social studies, science, math, language arts, and family life education. A teachers guide provides a chart that briefly describes each activity, indicating the skills and subject areas emphasized in each activity. The activities utilize a variety of teaching strategies including role-playing simulations, laboratory experiments; problem solving challenges; mathematical exercises; cooperative learning projects; research; discussion; and, values clarification. Twelve of the 13 chapters address specific issues of global society and environment: (1) Population Dynamics; (2) Climate Change; (3) Air Pollution; (4) Water Resources; (5) Deforestation; (6) Food and Hunger; (7) Waste Disposal; (8) Wildlife Endangerment; (9) Energy Issues; (10) Rich and Poor; (11) Population and Economics; (12) The World's Women; and (13) Finding Solutions. The final chapter, "Finding Solutions," includes activities that encompass the preceding topics. Also included are: suggested resources for further research; and population education resources available through Zero Population Growth, Inc. (MCO)

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EARTH Matters

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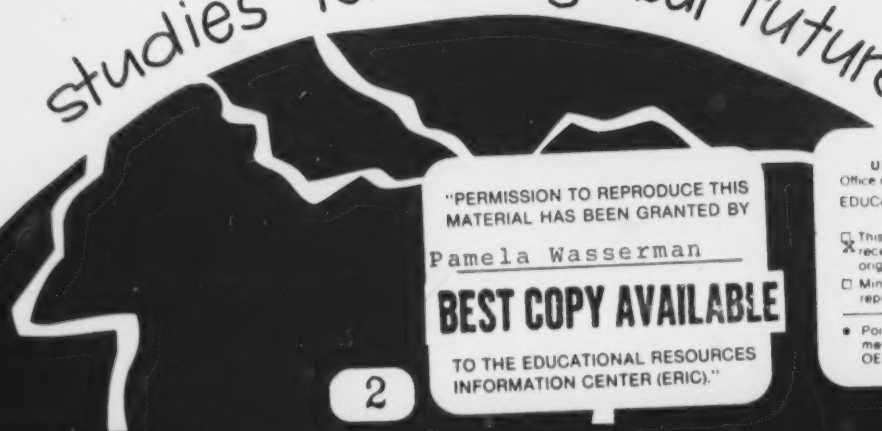
studies for our global future



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EARTH *Matters*

by
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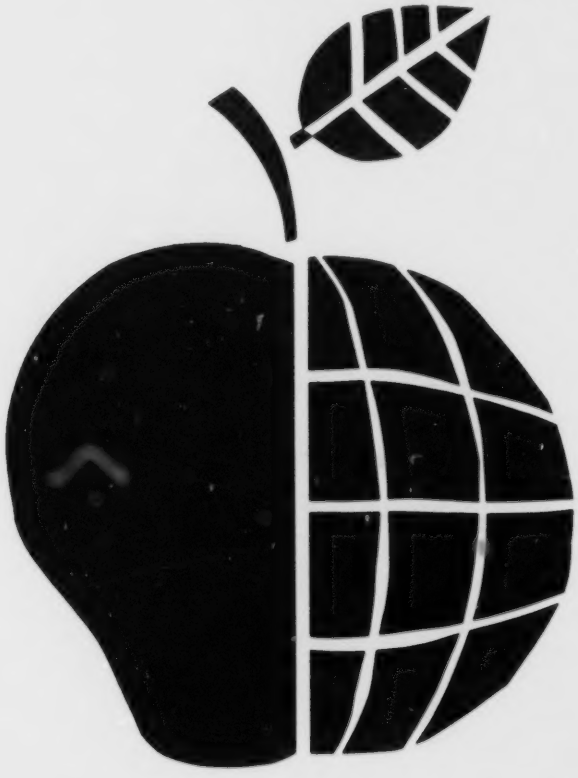
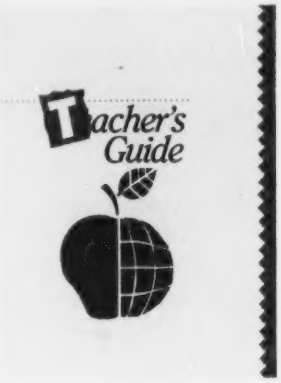


Teacher's Guide

Why *Earth Matters*?

Today's students inhabit a rapidly changing world where daily headlines warn of problems such as hunger, poverty, global warming, pollution and deforestation. Central to many of the pressing environmental, social and economic issues of our time are people—our numbers and our activities. Most of the threats to our global ecosystems and social structures are human-made, and are worsened by increasing numbers placing stress on finite resources and fragile economies. *Earth Matters* helps students explore these connections by linking human population growth and lifestyles to the health and well-being of the planet and all its inhabitants.

Through 12 readings and 32 innovative activities, *Earth Matters* introduces high school students to issues of the global environment and society, while challenging them to evaluate these issues critically and motivating them to develop solutions.



How to Use *Earth Matters*

Because the issues covered in *Earth Matters* are interdisciplinary, this book is designed for use in several curriculum areas. The readings and activities develop knowledge and skills applicable to high school social studies, science, math, language arts and family life education, and can be easily integrated into existing curriculum plans. The charts on the following pages briefly describe each activity, indicating which skills and subject areas are emphasized in each. Many of these activities also lend themselves to a team-teaching approach, where educators from different disciplines facilitate the activity.

There are a variety of ways to use *Earth Matters*. Although the book forms a complete unit on global environmental and social issues, each chapter or activity can stand alone to emphasize one particular topic or idea. We recommend that students complete the reading section in each chapter before participating in the corresponding activities. For more in-depth information on each issue, students and teachers should refer to the list of suggested resources at the end of the book.

All of the activities in *Earth Matters* are designed to engage students. A variety of teaching strategies including role-playing simulations, laboratory experiments, problem-solving challenges, mathematical exercises, cooperative learning projects, research, discussion and values clarification activities are employed to meet the needs of different educators and their individual teaching styles. The range of activities has been designed to develop a number of student skills including critical thinking, research, public speaking, writing, data collection and analysis, cooperation, decision making, creative problem-solving, reading comprehension, conflict resolution and values-clarification.

Twelve of the 13 chapters in *Earth Matters* address specific issues of the global society and environment, such as hunger, deforestation and energy consumption. The final chapter, "Finding Solutions," includes several activities which encompass all of the preceding topics. These activities encourage personal decision making and individual actions on critical issues that shape our lives. In this way, *Earth Matters* aims not only to enlighten students, but also to build skills, concern and commitment for effective global citizenship.

Teacher's Guide

Activity Subject Areas

Environmental Science

The Acid Tests
Are People the Problem?
Bye, Bye Birdie
Clearing the Air
Demographic Facts of Life
Eco-Ethics
An Energizing Policy
Getting Around
Go for the Green
Good News, Bad News
An International Greenhouse
Lots of Lemna
McFoam or McPaper:
The BigMac Wrap Debate
Methane and You
No Water Off a Duck's Back
A Nonbearing Account
Population Growth—It All Adds Up
Population Scavenger Hunt
Power of the Pyramids
Roll on Mighty River
Talkin' Trash on Tropico
Think Globally, Act Locally
To Log or Not to Log
A Toss of the Dice
Waste A-Weigh
Water, Water Everywhere

Biology

The Acid Tests
Bye, Bye Birdie
Demographic Facts of Life
Clearing the Air
Go for the Green
An International Greenhouse
Lots of Lemna
Methane and You
No Water Off a Duck's Back
Power of the Pyramids
A Toss of the Dice
Waste A-Weigh!
Water, Water Everywhere

Math

Demographic Facts of Life
The Lion's Share
Lots of Lemna
Power of the Pyramids
A Toss of the Dice
Water, Water Everywhere

Social Studies

Are People the Problem?
Changing Values
Clearing the Air
Demographic Facts of Life
Eco-Ethics
An Energizing Policy
Getting Around
Go for the Green
Good News, Bad News
The Hunger Banquet
An International Greenhouse
The Lion's Share
Living on Less Than $400 a Year
A Nonbearing Account
Population Growth—It All Adds Up
Population Scavenger Hunt
Power of the Pyramids
Roll on Mighty River
Think Globally, Act Locally
To Log or Not to Log
A Visit from Gynog
A Woman's Place

Economics

Changing Values
An Energizing Policy
Go for the Green
The Hunger Banquet
The Lion's Share
Living on Less Than $400 a Year
Population Growth—It All Adds Up
Talkin' Trash on Tropico
To Log or Not to Log

Language Arts

Bye, Bye Birdie
An Energizing Policy
An International Greenhouse
Living on Less Than $400 a Year
McFoam or McPaper:
The BigMac Wrap Debate
A Nonbearing Account
To Log or Not to Log
A Visit from Gynog
A Woman's Place

Family Life

Changing Values
Eco-Ethics
Getting Around
The Hunger Banquet
The Lion's Share
Living on Less Than $400 a Year
McFoam or McPaper:
The BigMac Wrap Debate
Population Growth—It All Adds Up
Think Globally, Act Locally
A Visit from Gynog
Water, Water Everywhere
A Woman's Place

SUMMARY OF ACTIVITIES

CHAPTER	ACTIVITY	DESCRIPTION	SKILLS
I. Population Dynamics	1. Lots of Lemna	Students collect data on the exponential growth of *Lemna* (duckweed) plants.	Data collection and recording estimation, math calculations, graphing, data analysis and interpretation
	2. A Toss of the Dice	Students use dice to model exponential growth, as well as two other kinds of population growth.	Math calculations
	3. Power of the Pyramids	Students construct and interpret population pyramids which illustrate age and sex distribution of populations in different countries. They use this information to discuss population projections for these countries.	Math calculations, graphing, data analysis and interpretation
	4. Demographic Facts of Life	Students calculate the rate of natural increase and corresponding doubling times for several countries and discuss differences. Students also examine the impact of world disasters on population growth.	Data collection and analysis, math calculations, interpretation
	5. Population Scavenger Hunt	Students attempt to accomplish up to 35 tasks related to improving their population literacy, earning points for each completed task.	Varies according to each of 35 tasks
II. Climate Change	6. An International Greenhouse	Students act as delegates to the United Nations Environmental Programme in this model United Nations simulation focusing on climate change issues.	Public speaking, research, parliamentary procedure, conflict resolution, negotiation
	7. Methane and You	Students study possible relationships between several human activities and production of methane, a greenhouse gas.	Data analysis, diagraming, graphing
III. Air Pollution	8. The Acid Tests	Students measure the effects of various pH solutions on radish seeds to determine the effect of acid rain on plant growth.	Laboratory preparation, data collection, data recording, data analysis, graphing, measuring, observation, sketching
	9. Clearing the Air	Students collect articles on air pollution problems throughout the world and create charts depicting causes, effects and possible solutions.	Chart interpretation, chart construction, data collection, reading comprehension

SUMMARY OF ACTIVITIES

CHAPTER	ACTIVITY	DESCRIPTION	SKILLS
IV. Water Resources	10. Water, Water Everywhere	Students observe a brief demonstration on the distribution of the world's water and then calculate their daily water use from direct and indirect sources.	Estimation, math calculations, graphing, observation, research, writing
	11. Roll on Mighty River	Students participate in a simulation to determine problems associated with water quality and distribution.	Public speaking/debate, library research, decision making
V. Deforestation	12. To Log or Not to Log	Students participate in a mock trial pitting loggers against environmentalists in a land use conflict over old-growth forests in the United States.	Research, public speaking, critical thinking, persuasion, evaluation
	13. Go for the Green	Students play a board game in which they make economic and environmental decisions regarding tropical rainforests.	Game strategy, decision making
VI. Food and Hunger	14. The Hunger Banquet	Students attend a luncheon where they are randomly assigned to a global economic area and get a first-hand look at the inequitable distribution of food and wealth worldwide.	Communication, bargaining, conflict resolution, strategic planning, writing
	15. Good News, Bad News	Students analyze statements about population and food issues and determine whether to categorize them as "good news" or "bad news." They then evaluate the statements as a whole to gain a total picture of the food and hunger situation.	Ranking and evaluation of data, data collection, critical thinking, writing
VII. Waste Disposal	16. Talkin' Trash on Tropico	Students design a solid waste disposal program for a mythical island after researching all of their options.	Research, writing, evaluation, cooperation, decision making
	17. McFoam or McPaper: The BigMac Wrap Debate	Students debate which fast food container (foam or paper) is better for the environment.	Critical thinking, research, public speaking/ debate, writing
	18. Waste A-Weigh!	Students weigh their food wastes each day in the cafeteria and compete with other classes to reduce waste.	Practicing conservation, brainstorming, collecting and recording data

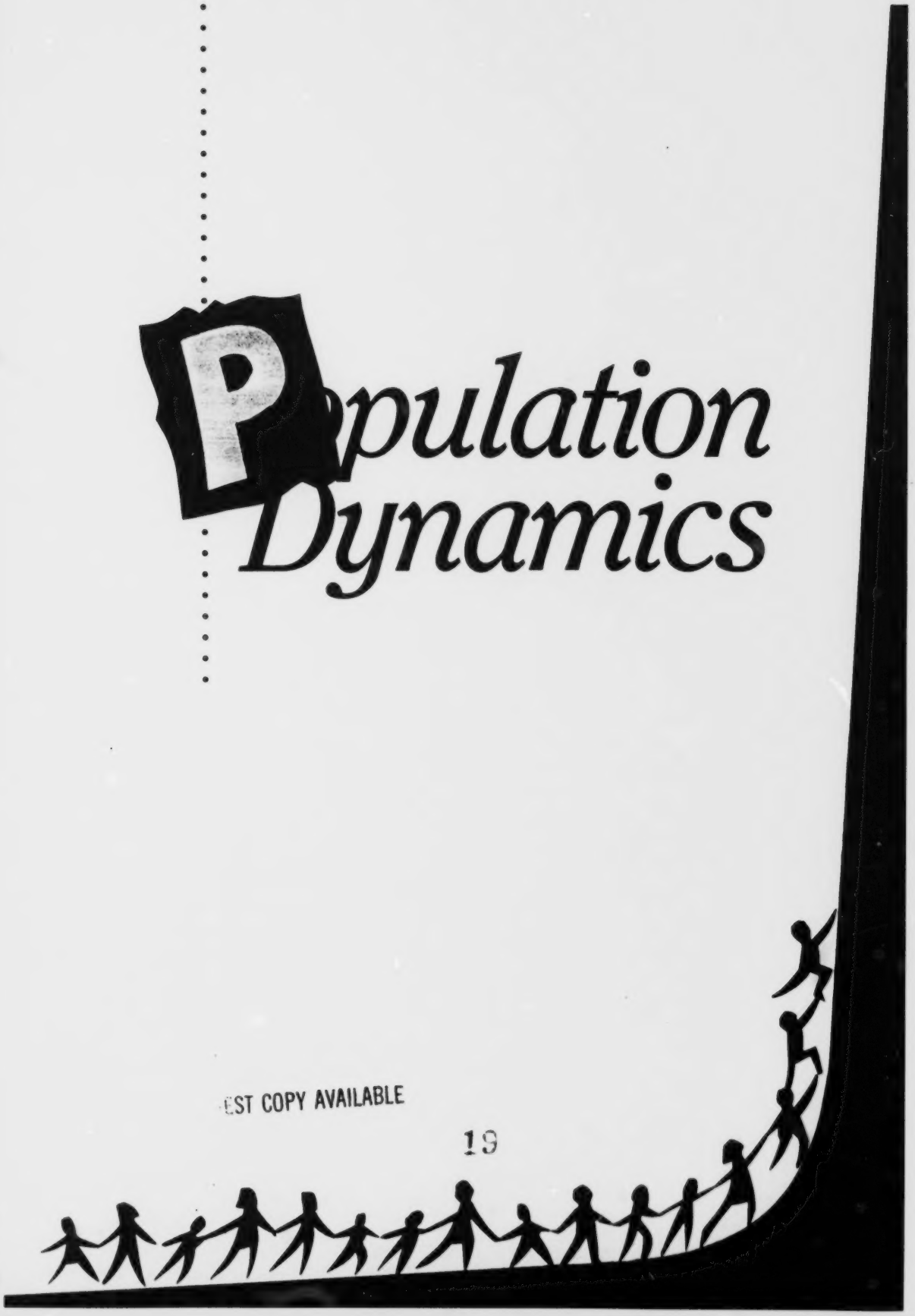
SUMMARY OF ACTIVITIES

CHAPTER	ACTIVITY	DESCRIPTION	SKILLS
VIII. Wildlife Endangerment	19. Bye, Bye Birdie	Students research various endangered species and develop criteria for determining which species should be saved, given limited resources.	Critical thinking, cooperation, library research, writing, public speaking, evaluation
	20. No Water Off a Duck's Back	Students conduct experiments on bird eggs and feathers to identify adverse effects of oil spills on wildlife.	Laboratory preparation, math calculations, observation, graphing, drawing, data analysis, discussion
IX. Energy Issues	21. Are People the Problem?	Students compare U.S. energy consumption habits with those of other countries and discuss the relationship between population and energy use.	Math calculations, data interpretation
	22. Getting Around	Students devise a survey on transportation habits, administer it in the community, and evaluate findings.	Development and administering of a survey, tabulation and interpretation of results, evaluation
	23. An Energizing Policy	Students act as presidential advisors to formulate their own energy policies for the nation.	Critical thinking, research, writing, decision making, persuasion
X. Rich and Poor	24. The Lion's Share	Students study the relationship between income and family size as an aid to seeing how a country's per capita income varies with its population and gross domestic product (GDP).	Data analysis, math calculations, research and preparation of a budget
	25. Living on Less than $400 a Year	Students read and discuss how the average person lives in less developed countries and brainstorm possible ways to alleviate global inequities.	Brainstorming, cooperation, problem-solving, evaluation, critical thinking
XI. Population and Economics	26. Population Growth—It All Adds Up	Students collect advertisements which promote growth and discuss whether an increased quality of life can be achieved without growth.	Data collection and analysis, critical thinking, research, discussion
	27. Changing Values	Students examine principles of growth that have been traditionally held in the United States and determine whether they have changed in recent years.	Reasoning, values-clarification

SUMMARY OF ACTIVITIES

CHAPTER	ACTIVITY	DESCRIPTION	SKILLS
XII. The World's Women	28. A Woman's Place	Students examine the status of women in India and develop brief oral reports on the status of women in different countries.	Cooperation, research, interpretation, public speaking/discussion
	29. A Visit from Gynog	Students act as anthropologists from a mythical planet to analyze women's place in contemporary American culture.	Observation, cooperation, research, interpretation, public speaking
XIII. Finding Solutions	30. Eco-Ethics	Students determine their personal code of environmental ethics by choosing responses to specific environmental dilemmas.	Decision making, discussion, reasoning, writing
	31. Think Globally, Act Locally	Students list possible individual actions they can take to alleviate each of the problems addressed in this book, and determine the feasibility of each action.	Brainstorming, evaluation, critical thinking
	32. A Nonbearing Account	Students analyze a proposal for combatting overpopulation and then devise their own plans.	Critical thinking, discussion, creativity, writing

Population Dynamics



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The People Connection

Student Reading

While we eat, sleep, work and study, a silent, steady explosion is forever changing the world around us. Although barely noticeable on a day-to-day basis, this explosion threatens the health of our planet and the quality of life for all its inhabitants. This explosion is not fueled by dynamite or nuclear bombs, but by us—humans.

The size of the human population is now approaching six billion and is expected to double in just 40 years. Each year, about 95 million more people are added to the Earth. That's more than another Mexico a year, another New York City each month, another Houston each week, and another Iceland each day. In the six seconds it takes you to read this sentence, 18 more people will be added to the planet.

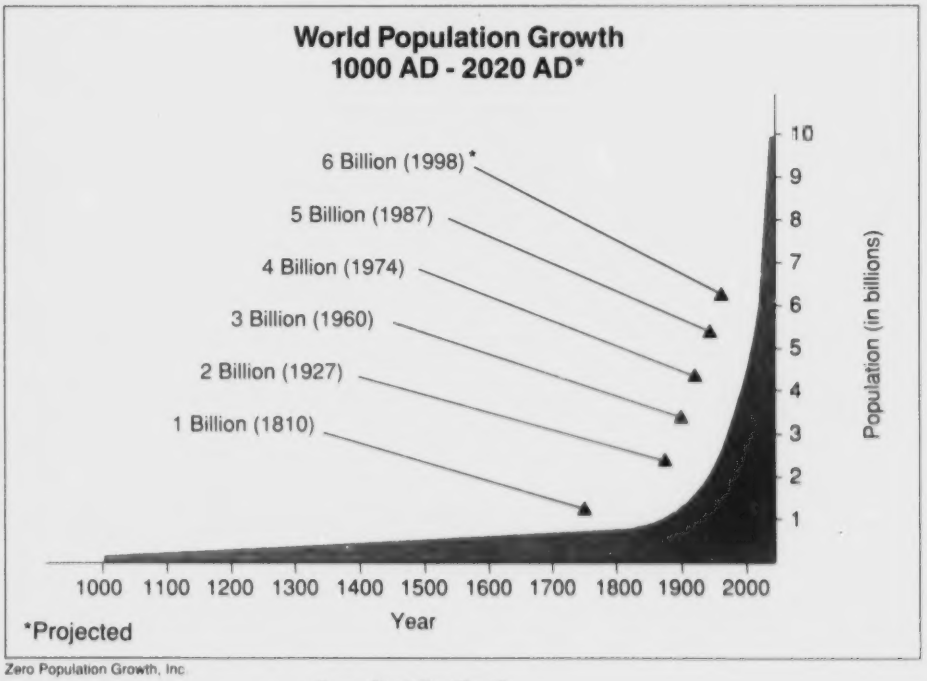
What Ignited the Explosion?

The population explosion has been very recent in the scope of human history. People lived on Earth for about three million years before the world population reached 500 million around 1600. Until then, birth rates and death rates were in balance, keeping the population stable. Although birth rates were high, death rates—particularly among children—also remained high.

By the 17th century, this balance of birth and death rates began to change as advances in medical care, sanitation, food production and nutrition increased life expectancy for children and adults. Death rates dropped, but birth rates remained high and the population grew steadily. By 1800, at the height of the Industrial Revolution in North America and Europe, global population reached one billion.

As industrialization grew throughout the Western world, people exchanged their agrarian lifestyles for homes and jobs in burgeoning cities. Without land to farm, large families became neither necessary nor practical. Slowly, birth rates dropped in rapidly industrializing nations. This population pattern is now referred to as the "demographic transition."

In the less developed world, however, birth rates remained high at the same time that death rates dropped as new agricultural and medical technologies were imported from more developed countries. Unfortunately, economic conditions in these nations did not always improve as life spans increased. The result has been a population explosion and stagnation in the middle of the demographic transition pattern throughout much of the globe. By 1960, the world population reached three billion. Just 15 years later, in 1975, the population soared to four billion and topped five billion in 1987. Before the year 2000, the Earth will have more than six billion people.



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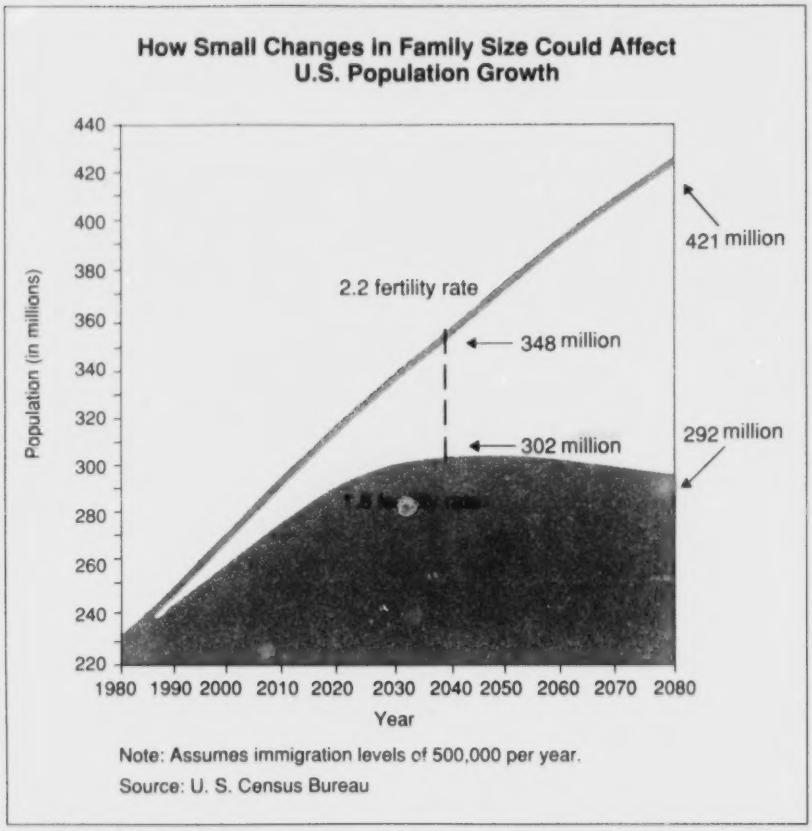
Crowding the Earth

Because the Earth is a finite system, the exponential growth of human numbers cannot continue indefinitely. Every environment has a carrying capacity—the point at which there are not enough natural resources to support any more members of a given species.

Growing environmental problems and resource depletion suggest that humans are dangerously close to exceeding the Earth's carrying capacity. Only a small fraction (1/32) of all the land in the world is arable. The rest has been built up into cities and towns or is inhospitable to growing crops. While the number of people continues to grow, the small portion of land which must support these people remains the same, or shrinks as cities expand. Already, one billion people (about one-fifth of the world's population) suffer from malnutrition, due to the lack of adequate food supplies.



Zero Population Growth, Inc.

The size of the human population affects virtually every environmental condition facing our planet. As our population grows, demands for resources increase, adding to pollution and waste. More energy is used, escalating the problems of global warming, acid rain, oil spills and nuclear waste. More land is required for agriculture, leading to deforestation and soil erosion. More homes, factories and roads must be built, occupying the habitat of other species which share the planet, leading increasingly to their extinction. Simply put, the more people inhabiting our finite planet, the greater stress on its resources.

Population Growth: American-Style

Because most of the population increase today is occurring in developing countries, many Americans feel that they neither contribute to nor are affected by the problem. In fact, the United States is the fastest growing industrialized country, growing by two to three million people each year. This particularly affects the global environment, as affluent lifestyles in the United States place disproportionate demands on the world's resources. The next 100 million Americans, for example, are expected to consume more oil, gas and minerals than do all of today's 1.4 billion Africans and Indians. The 30 million people likely to be added to the U.S. population in the next 15 years will create more solid waste and carbon dioxide emissions than the combined population increase of South America and Africa for the same period of time.

Evidence of U.S. population growth surrounds us—intensifying traffic congestion, declining air and water quality, and landfills too full to handle the mounting garbage and hazardous waste which Americans create daily. Many attribute these problems solely to wasteful habits. However, increasing numbers of Americans exercising these habits only serve to compound the problems. Efforts to relieve environmental stress by cutting consumption would be undermined, if not negated, by continued population growth or by stabilization at a size larger than our resources can sustain.

What Can Be Done?

While global population growth and the problems it poses may seem insurmountable, there is much that can be done to stop the population explosion and preserve the

environment. Certainly, we can encourage our government to help us and other nations deal with population and environmental problems. The only humane solution to the population explosion is the voluntary lowering of birth rates worldwide. Education, family planning programs and other initiatives which give people options and incentives to have smaller families need to be more widely implemented.

But there are also things we can do as individuals, choices we can make in our lifestyles and in how we raise our families, that will significantly reduce the stress on our resources and ecosystems. We can protect our environment by making thoughtful choices about where we live, how we use energy in our homes, what we eat, how we travel, and whether and how we use "throw-aways." By making such choices, we can have a collective, healing impact on the biological systems that sustain us.

Because each person makes a huge impact on the environment, we each need to make careful decisions about the size of the next generation, beginning with the size of our own families. If couples haves more than two children, the population will continue to grow. Young couples are already recognizing the benefits of waiting until they're older to have children and spacing their births by several years—two factors that slow the growth rate.

Do such choices really make a difference? Compare two families: After four generations, a family with a three-child tradition will consume 160 percent more resources (including fish, meat, wood and vegetable products) than a two-child-per-generation family.

A child's best chance for a happy life flows from a combination of things: parental love; adequate food, water and shelter; and the security that comes from finding, as he or she grows older, that the next generation will have these resources. Two commitments can protect such a legacy for the world's children: responsible parenting and caring for the environment. Prospective parents should take heed of anthropologist Margaret Mead's observation that "issuing fewer invitations to the next generation will make certain that all of those invited will have a better time."

The Population Clock

		World	United States
1991 Population (est.)		**5.4 billion**	**2.52 million**
Births per:	Year	145,368,000	4,284,000
	Month	12,114,000	357,000
	Week	2,795,538	82,385
	Day	398,268	11,737
	Hour	16,595	489
	Minute	277	8
	Second	5	-
Deaths per:	Year	48,458,000	2,268,000
	Month	4,038,000	189,000
	Week	931,846	43,615
	Day	132,756	6,213
	Hour	5,532	259
	Minute	92	4
	Second	2	-
Natural Increase:	Year	92,912,000	2,016,000*
	Month	8,076,000	168,000*
	Week	1,863,692	38,770*
	Day	265,512	5,523*
	Hour	11,063	230*
	Minute	184	4*
	Second	3	-

* These figures do not include net immigration which is estimated to add at least 500,000 each year to the U.S. population.

Lots of Lemna

Student Activity 1

Concept: Populations grow exponentially in environments without limiting factors.

Objectives: Students collect data on the geometric growth of a *Lemna* (duckweed) population and graph results. They then extend their lesson of exponential growth to encompass human population growth.

Subjects: Biology, math, environmental science

Skills: Data collection and recording, estimation, math calculations, graphing, data analysis and interpretation

Materials:

10 *Lemna* plants (duckweed)
10-gallon aquarium with water and aerator

Introduction:

When modeling exponential growth in the science classroom, it is useful to use living organisms whose growth can be easily measured. This activity uses a small, floating, aquatic flowering plant of the genus *Lemna* (duckweed) to investigate geometric population growth. *Lemna* is small enough to have a sufficiently rapid reproduction rate, yet large enough to be easily seen and counted. As individual *Lemna* leaves grow and enlarge, they break apart from the parent plant and form new plants. *Lemna* can reproduce and double its number in less than five days if the growing conditions are adequate. As *Lemna* grows and reproduces, it forms a population of floating plants on the surface of the water. Within three months, a definite J-curve can be obtained, and within five to six months, *Lemna* will entirely cover the surface of a 10-gallon aquarium with an estimated 10,000 individual plants.

Procedure:

Because of the time involved with this activity, it is necessary to start the lab five months prior to when the lesson on population is introduced.

1. Several days prior to the class period when the lesson is introduced to the students, set up the aquarium as follows: Prepare a 10-gallon aquarium with aged water aerated with a single pump. On the day you begin the activity with students, place ten *Lemna* plants in the tank. *Lemna* can be field collected or purchased at a supply house. They often grow in aquaria at tropical fish shops. Leave the aquarium light on at all times. When water begins to evaporate from the tank, replace with aged tap water.
2. Let students know that they will be collecting data on the population growth of *Lemna*. You might like to have the class predict the reproduction rate and doubling time of *Lemna*.
3. You may wish to have the students study the *Lemna* plant under a microscope. Students can do background reading on the genus, investigating such information as the geographic range of *Lemna* and the best ecological conditions for growth.
4. Have students construct a data collection sheet in their notebooks with columns for the day recorded and for population size. Explain how to measure and record the population size. Counting the number of plants should take only a few minutes every couple of days. The students will discover that for several days, no population increase will occur, and then within one day, the population will increase significantly. These "spurts" in reproduction are to be expected and represent important lessons in growth and development. After several months, the number of plants becomes too large to easily count. Try to get the students to devise a method of measurement that is appropriate for large numbers. One method is to:
   a) calculate the surface area of the aquarium;
   b) average, from ten samples, the number of *Lemna* plants per square cm.;
   c) estimate the percentage of the surface covered by the plants;
   d) calculate the population size by multiplying a x b x c.

   At this point students should note on their data sheets the percentage of surface covered by the *Lemna*. Students who count on the same day may not have the same numbers for population size on their data sheets. Although students should be taught the importance of accurate data collection, the time of day that students count the number of plants will vary and small errors will be more common as the population size increases and as students estimate the population size with indirect measures.
5. After students have finished collecting data, ask them to graph the results. The graph will be a typical geometric curve. Discuss with them the nature of the curve and what it means when a curve increases in this manner. Perhaps you will want the students to predict future populations if the growth rate were to continue. What are the implications when population growth is "out of control"? If organisms follow a geometric growth curve, why isn't the world hopelessly overpopulated with plants and animals? Why haven't

most populations of organisms followed the J-curve? Why don't populations of natural organisms go out of control? Have the students identify natural factors which help control population sizes and introduce the concepts of environmental resistance, limiting factors and the S-curve.

Follow-up Activities:

Activity 1: A Human J-Curve

Students can now extend the concept of exponential growth into the area of human population growth. Copy the table below onto the chalkboard. Have the students graph human population growth. This graph should stimulate discussions as to why humans do not follow the S-curve. Is environmental resistance operating with humans? What is the future for human populations? What decisions must be made? What are the implications of human population growth for future resource use, for disease control or for environmental quality?

Year (A.D.)	Population (in millions)
1	170
200	190
400	190
600	200
800	220
1000	265
1100	320
1200	360
1300	360
1400	350
1500	425
1600	545
1700	610
1750	760
1800	900
1850	1,210
1900	1,625
1950	2,515
2000*	6,250
2050*	8,060

*Projected

Data: For 1 A.D. through 1975: *The Atlas of World Population History* by C. McEvedy and R. Jones, New York: Penguin Books, 1978. For 1975 to 2020: Population Reference Bureau, 1875 Connecticut Avenue, N.W., Suite 520, Washington, D.C. 20009.

Adapted with permission from the National Association of Biology Teachers. The original activity, "Using Lemna to Study Geometric Population Growth," by Larry DeBuhr, appears in The American Biology Teacher, *Vol. 53, No. 4, April 1991, pp. 229-232.*

Activity 2: Bacteria Bottles

This puzzle illustrates the concept of exponential growth using bacteria. Invite students to try it on friends and family.

Bacteria multiply by division. One bacterium becomes two. Then two divide into four; the four divide into eight, and so on. For a certain strain of bacteria, the time for this division process is one minute. If you put one bacterium in a bottle at 11:00 p.m., by midnight the entire bottle will be full.

1. When will the bottle be half-full? How do you know?

A. The bottle will be half-full at 11:59 p.m. because the doubling time is one minute and the bottle will be full at midnight.

2. Suppose you could be a bacterium in this bottle. At what time would you first realize that you were running out of space?

A. Answers will vary. To clarify, ask students: "At 11:55 p.m., when the bottle was only three percent full and 97 percent empty, would it be easy to perceive that there was a space problem?"

3. Suppose that at 11:58 some bacteria realize that they are running out of space in the bottle. So they launch a search for new bottles. They look far and wide. Finally, offshore in the Arctic Ocean, they find three new empty bottles. Great sighs of relief come from all the bacteria. This is three times the number of bottles they've known. Surely, they think, their space problems are over. Is that so? Explain why the bacteria are still in trouble. Since their space resources have quadrupled, how long can their growth continue?

A. With space resources quadrupled, the bacteria have two more doubling times, or two minutes before they will run out of space.

11:58 p.m.: Bottle 1 is one-quarter full.
11:59 p.m.: Bottle 1 is half-full.
12:00 a.m.: Bottle 1 is full.
12:01 a.m.: Bottles 1 and 2 are full.
12:02 a.m.: Bottles 1, 2, 3 and 4 are all full.

4. Does what you have learned about bacteria suggest something about human population growth?

A Toss of the Dice

Student Activity 2

Concept: Within the last two centuries, human population growth has increased exponentially. The absence of widespread family planning contributes to the geometric growth of human populations.

Objective: Students use dice to model exponential growth, as well as two other population growth models.

Subjects: Math, biology, environmental science

Skills: Math calculations

Materials:

200-300 dice (or wood or sugar cubes with different colored sides)
2 large, open-ended containers (e.g. coffee can, milk carton, etc.)
Copies of Student Worksheet
Graph paper

Note: Dice can be purchased at game stores. *The Exponential Growth Model*, including 200 dice, can be purchased for $35.95 from Scott Resources, P.O. Box 2121, Fort Collins, CO 80522; 800/289-9299.

Introduction:

Population, non-renewable resource consumption, food production, industrial output and pollution generation have all been increasing exponentially. To understand the resource and environmental crises, one must understand exponential growth. This lab is designed to give that understanding, while illustrating three models of population growth.

Procedure:

In this experiment, students will use dice to model population growth. Each die represents a person. Each throw represents a year. A *3* or a *6* represents the birth of a child, so each time one of them comes up, add a die to the population. If a *1* comes up, a death has occurred, so remove that die from the population. Hence, you are modeling a situation where the birth rate is twice the death rate. You also have a population growth rate of 1/6 or about 17 percent.

Have students follow these instructions:

PART A: Unrestricted Exponential Growth

Put ten ordinary dice into a container (Adam, Eve, Cain, Abel, Sally, Alice, Dick, Jane, Bob and Sue). Shake the container and dump the contents out onto a smooth, hard floor. Remove and count all the *1*'s that appear. A *1* is analogous to a death. Record the number of deaths on the chart for Part A. Count up all the *3*'s and *6*'s that appear. Since they correspond to births, add a die to the container for each of them. Then fill in the required information on the chart. Repeat the above procedure until the total population exceeds 500 people. When the population grows beyond the number of dice or cubes that you have available, either roll twice or double your results.

PART B: The Effect of Instituting a Limited Family Planning Program

Return to the year where your population was almost 100 people. Put that many dice into the container. But now introduce a limited birth control program. This will be modeled by saying that a *3* represents a birth, as before, and so does every other *6*. However, the remaining half of the *6*'s represent women who use contraceptives (or whose male partner uses contraceptives) and so these births have been prevented. If an odd number of *6*'s comes up, round off in favor of a birth half of the time, and in favor of a prevented birth in the other half of the cases. Model this situation, from where you start, for twelve throws of the dice. You have essentially cut the population growth rate from 17 percent to 8 percent.

PART C: The Zero Population Growth Plan

Again return to the year where your population was almost 100 people. Put that many dice into the container. But now introduce a large-scale family planning program. This will be modeled by saying that all *6*'s represent women using effective contraceptives or women whose male partners use effective contraceptives. Hence, a *1* represents a death, a *3* represents a birth, and a *6* represents a prevented birth. Model this situation from where you start for twelve throws of the dice.

PART D: World Population Trends

The following is a listing of estimates of world population from 1650 to 1990. Figures such as these are compiled by the United Nations and are published in most almanacs.

Year	Population (in millions)
1650	575
1750	760
1850	1,210
1900	1,630
1930	2,100
1940	2,300
1950	2,500
1960	3,000
1970	3,600
1980	4,400
1990	5,300

Plot a graph of world population vs. time (1650 to 1990).

Adapted with permission from Kendall/Hunt Publishing Company. The original activity, "Modeling Exponential Growth," appears in Global Science: Energy, Resources, Environment Laboratory Manual. *Copyright 1981, 1984, 1991 by Kendall/Hunt Publishing Company.*

A Toss of the Dice

Student Worksheet

Part A. Unrestricted Exponential Growth

Throw No. (Year)	Number of Births	Number of Deaths	Number of Dice (Population)	Population Growth Rate
0	—	—	10	—
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Part B: The Effect of Instituting a Limited Family Planning Program

Throw No. (Year)	Number of Births	Number of Deaths	Number of Dice (Population)	Population Growth Rate

Part C: The Zero Population Growth Plan

Throw No. (Year)	Number of Births	Number of Deaths	Number of Dice (Population)	Population Growth Rate

Power of the Pyramids

Student Activity 3

Procedure:

1. Distribute graph paper and copies of the Student Worksheets to students.
2. The figures on the worksheet represent the population (in thousands) of each age group within each gender for each particular country. In order to construct pyramids for each country, students must first calculate the percentage of the population in each subgroup.

   Example: Kenya's total population in 1990 was 24,987,000. The population of males up to age four was 2,701,000.

   $$\frac{2{,}701{,}000}{24{,}987{,}000} = .11 \text{ or } 11\%$$

   Students should complete these calculations for each age group.
3. Using graph paper, students can now construct a population pyramid as in the example. The figures along the X-axis represent the calculated percentages of the population, while points along the Y-axis represent age groups. A line drawn down the middle of the graph separates the male and female populations. Students should use a different color for each side of the graph (see sample on following page).

Suggested Answers to Student Worksheet 3:

1. Male. There is a slightly greater probability of giving birth to male children. For every 100 girls born, there are 105 boys born.
2. Female. Throughout the world, life expectancy for women is higher than for men. This is due to a number of genetic and social factors. In general, men are more prone to certain health risks than women.
3. Kenya and Brazil. Their populations are growing very rapidly. These pyramids will look roughly the same in 25 years if birth and death rates remain the same. A lower fertility rate or higher death rate would change the shape of the pyramid.
4. Austria. The largest age group is aged 25-29, while the youngest Austrians make up a smaller percentage of the total population. If parents continue to have small families, the largest group will gradually move up into the higher age brackets (i.e., in 25 years, the largest group will be aged 50-54). The rest of the pyramid will be shaped like a solid rectangle. This indicates a stable population.
5. The shapes are similar. The United States in 1990 had a higher fertility rate (2.0 children) than Japan (1.6 children). The bulges in the middle of each pyramid are attributed to the post-World War II Baby Boom.
6. China's largest age group in 1990 was in the 15–24 age range. In 1979, in response to an escalating population and diminishing resources, the Chinese government instituted its "one-child family" policy. Through a variety of incentives and disincentives, the policy encourages parents to have only one child, or at most two.
7. United States (21.7%); Brazil (35.3%); China (26.2%); Japan (18.5%); Kenya (53%); Austria (17.6%). Countries with the highest percentage of their population yet to enter childbearing age will experience the highest rate of growth.
8. Kenya and Brazil. Much of the world is experiencing rapid population growth. This trend is likely to continue if a large percentage of the world's population has yet to enter its reproductive years. Although many developed countries are close to achieving zero population growth (z.p.g.), most countries are experiencing annual growth rates over two percent (doubling in less than 35 years).

Concept: The age and sex distribution of a regional or national population affects its growth rate.

Objectives: Students will construct and interpret population pyramids and discuss differences in population growth rates.

Subjects: Math, demography, biology, social studies, environmental science

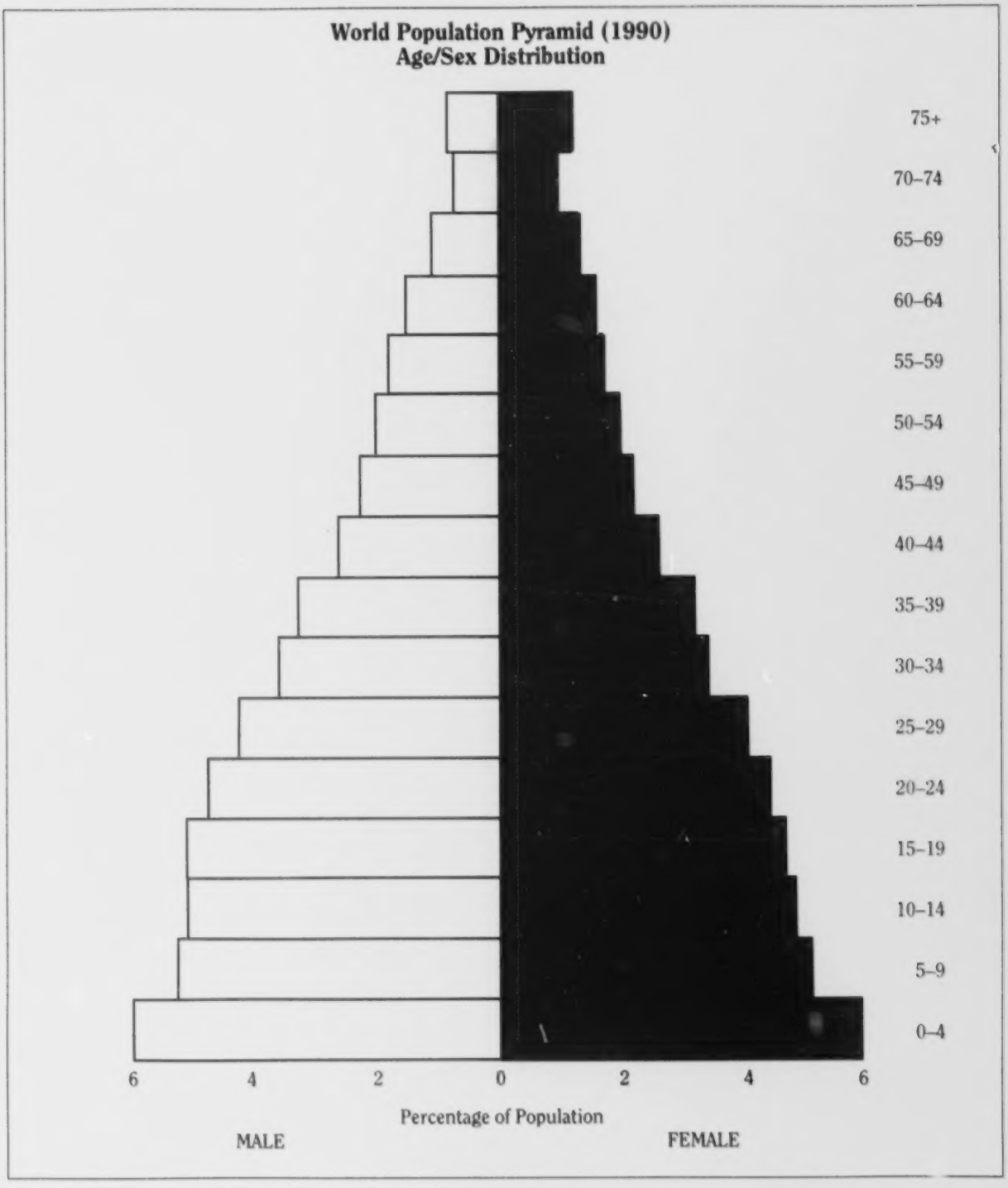
Skills: Math calculations, graphing, data analysis and interpretation

Materials:

Graph paper
Colored pencils
Rulers
Calculators
Overhead transparency of "World Population Pyramid" (on following page)
Copies of Student Worksheets

Power of the Pyramids

Sample Pyramid



Population in Thousands (1990)												
	United States				Brazil				China			
Age Group	Male	%	Female	%	Male	%	Female	%	Male	%	Female	%
0 – 4	9,655		9,205		9,616		9,284		55,782		53,655	
5 – 9	9,355		8,941		8,993		8,856		44,942		42,316	
10 – 14	8,700		8,311		8,173		8,124		49,905		46,040	
15 – 19	8,846		8,451		7,425		7,422		63,890		59,174	
20 – 24	9,632		9,314		6,919		6,903		65,818		61,211	
25 – 29	10,906		10,741		6,752		6,751		51,882		50,504	
30 – 34	11,167		11,059		5,754		5,786		43,832		40,254	
35 – 39	10,264		10,289		4,853		4,906		45,043		41,707	
40 – 44	8,823		9,016		3,891		3,932		33,588		30,066	
45 – 49	6,868		7,163		3,053		3,098		26,306		23,015	
50 – 54	5,564		5,925		2,596		2,670		24,449		21,333	
55 – 59	5,059		5,569		2,095		2,201		22,224		19,912	
60 – 64	4,991		5,785		1,729		1,860		17,897		16,601	
65 – 69	4,530		5,564		1,285		1,422		13,536		13,557	
70 – 74	3,488		4,660		885		978		9,077		9,977	
75+	4,275		7,726		903		1,112		8,307		11,199	
TOTAL	122,124		127,717		74,891		73,305		576,479		540,523	
TOTAL	249,841				150,196				1,117,002			

Source: The World Bank, *World Population Projections 1989-90 Edition* (Baltimore: The Johns Hopkins University Press, 1990).

Population in Thousands (1990)												
	United States				Brazil				China			
Age Group	Male	%	Female	%	Male	%	Female	%	Male	%	Female	%
0 – 4	9,655	3.9	9,205	3.7	9,616	6.4	9,284	6.2	55,782	5.0	53,655	4.8
5 – 9	9,355	3.7	8,941	3.6	8,993	6.0	8,856	5.9	44,942	4.0	42,316	3.8
10 – 14	8,700	3.5	8,311	3.3	8,173	5.4	8,124	5.4	49,905	4.5	46,040	4.1
15 – 19	8,846	3.5	8,451	3.4	7,425	4.9	7,422	4.9	63,890	5.7	59,174	5.3
20 – 24	9,632	3.9	9,314	3.7	6,919	4.6	6,903	4.6	65,818	5.9	61,211	5.5
25 – 29	10,906	4.4	10,741	4.3	6,752	4.5	6,751	4.5	51,882	4.6	50,504	4.5
30 – 34	11,167	4.5	11,059	4.4	5,754	3.8	5,786	3.9	43,832	3.9	40,254	3.6
35 – 39	10,264	4.1	10,289	4.1	4,853	3.2	4,906	3.3	45,043	4.0	41,707	3.7
40 – 44	8,823	3.5	9,016	3.6	3,891	2.6	3,932	2.6	33,588	3.0	30,066	2.7
45 – 49	6,868	2.8	7,163	2.9	3,053	2.0	3,098	2.1	26,306	2.4	23,015	2.1
50 – 54	5,564	2.2	5,925	2.4	2,596	1.7	2,670	1.8	24,449	2.2	21,333	1.9
55 – 59	5,059	2.0	5,569	2.2	2,095	1.4	2,201	1.5	22,224	2.0	19,912	1.8
60 – 64	4,991	2.0	5,785	2.3	1,729	1.2	1,860	1.2	17,897	1.6	16,601	1.5
65 – 69	4,530	1.8	5,564	2.2	1,285	0.9	1,422	0.9	13,536	1.2	13,557	1.2
70 – 74	3,488	1.4	4,660	1.9	885	0.6	978	0.7	9,077	0.8	9,977	0.9
75+	4,275	1.7	7,726	3.1	903	0.6	1,112	0.7	8,307	0.7	11,199	1.0
TOTAL	122,124	48.9	127,717	51.1	74,891	49.9	73,305	50.1	576,479	51.6	540,523	48.4
TOTAL	249,841				150,196				1,117,002			

Source: The World Bank, *World Population Projections 1989-90 Edition* (Baltimore: The Johns Hopkins University Press, 1990).

* Students' answers may vary slightly, due to roundings.

Population in Thousands (1990)												
	Japan				Kenya				Austria			
Age Group	Male	%	Female	%	Male	%	Female	%	Male	%	Female	%
0 – 4	3,536		3,376		2,701		2,661		218		207	
5 – 9	3,814		3,626		2,191		2,171		240		226	
10 – 14	4,368		4,144		1,743		1,748		224		211	
15 – 19	5,137		4,876		1,267		1,269		257		244	
20 – 24	4,586		4,362		1,016		1,013		311		298	
25 – 29	4,155		4,018		829		856		328		317	
30 – 34	3,933		3,858		641		687		292		284	
35 – 39	4,539		4,476		500		530		255		252	
40 – 44	5,367		5,312		386		405		255		250	
45 – 49	4,506		4,551		290		315		256		257	
50 – 54	4,018		4,101		234		255		221		225	
55 – 59	3,798		3,943		195		208		186		199	
60 – 64	3,219		3,499		154		164		171		217	
65 – 69	2,160		2,888		111		116		149		242	
70 – 74	1,513		2,206		76		78		80		140	
75+	2,069		3,394		88		89		157		342	
TOTAL	60,714		62,630		12,421		12,566		3,608		3,912	
TOTAL	123,344				24,987				7,520			

Source: The World Bank, *World Population Projections 1989-90 Edition* (Baltimore: The Johns Hopkins University Press, 1990).

Population in Thousands (1990)												
	Japan				Kenya				Austria			
Age Group	Male	%	Female	%	Male	%	Female	%	Male	%	Female	%
0 – 4	3,536	2.9	3,376	2.7	2,701	10.8	2,661	10.6	218	2.9	207	2.8
5 – 9	3,814	3.1	3,626	2.9	2,191	8.8	2,171	8.7	240	3.2	226	3.0
10 – 14	4,368	3.5	4,144	3.4	1,743	7.0	1,748	7.0	224	3.0	211	2.8
15 – 19	5,137	4.2	4,876	4.0	1,267	5.1	1,269	5.1	257	3.4	244	3.2
20 – 24	4,586	3.7	4,362	3.5	1,016	4.1	1,013	4.1	311	4.1	298	4.0
25 – 29	4,155	3.4	4,018	3.3	829	3.3	856	3.4	328	4.4	317	4.2
30 – 34	3,933	3.2	3,858	3.1	641	2.6	687	2.7	292	3.9	284	3.8
35 – 39	4,539	3.7	4,476	3.6	500	2.0	530	2.1	255	3.4	252	3.4
40 – 44	5,367	4.4	5,312	4.3	386	1.5	405	1.6	255	3.4	250	3.3
45 – 49	4,506	3.7	4,551	3.7	290	1.2	315	1.3	256	3.4	257	3.4
50 – 54	4,018	3.3	4,101	3.3	234	0.9	255	1.0	221	2.9	225	3.0
55 – 59	3,798	3.1	3,943	3.2	195	0.8	208	0.8	186	2.5	199	2.6
60 – 64	3,219	2.6	3,499	2.8	154	0.6	164	0.7	181	2.4	217	2.9
65 – 69	2,160	1.8	2,888	2.3	111	0.4	116	0.5	149	2.0	242	3.2
70 – 74	1,513	1.2	2,206	1.8	76	0.3	78	0.3	80	1.1	140	1.9
75+	2,069	1.7	3,394	2.8	88	0.4	89	0.4	157	2.1	342	4.5
TOTAL	60,714	49.2	62,630	50.8	12,421	49.7	12,566	50.3	3,608	48.0	3,912	52.0
TOTAL	123,344				24,987				7,520			

Source: The World Bank, *World Population Projections 1989-90 Edition* (Baltimore: The Johns Hopkins University Press, 1990).

* Students' answers may vary slightly, due to roundings.

Power of the Pyramids

Student Worksheet 3

1. Which gender has the higher population in the youngest age groups on every pyramid? Why is that the case?

2. Which gender has the higher population in the oldest age groups? Why might that be so?

3. Of the six graphs, which two look most like pyramids? What does that indicate about their population growth rates? If birth and death rates remain the same in these countries, what will the pyramids look like in 25 years? What factors would change the shape of the pyramids?

4. Looking at the pyramids, which country appears to have the slowest rate of population growth? How can you tell? If current trends continue, how might this pyramid look in 25 years?

5. How do the pyramids for Japan and the United States compare? Which of the two countries, do you think, has the higher fertility rate? What might be attributed to the bulges in the middle of each of these pyramids?

6. What is different about the shape of China's pyramid? What unique factors have given the pyramid this shape?

7. For each country, determine the percentage of the population that has yet to reach its childbearing years (under age 15). What do these numbers say about the prospects for future population growth?

8. Which countries' pyramids are closest to the sample "World Population Pyramid"? What conclusions can you draw from this?

Demographic Facts of Life

Student Activity 4

Concept: The discrepancy between a population's birth and death rates determines rate of growth.

Objectives: Students calculate the rate of natural increase and corresponding doubling times for several countries and discuss differences.

Students examine the impact of world disasters on population growth.

Subjects: Math, biology, demography, environmental science, social studies

Skills: Data collection, analysis and interpretation, math calculations

Materials:

Copies of Student Worksheet
Calculators

Introduction:

Birth and death rates determine the rate of population growth. If the birth and death rates are similar, a population experiences little or no growth. When the birth rate far exceeds the death rate, the population soars. These rates are expressed as the number of births or deaths for every 1,000 people in a given year. For instance, in 1991 the world's birth rate was 27 per 1,000 and the death rate was 9 per 1,000. Using the formulas below, we can determine the world's annual growth rate and the number of years it will take the population to double if the growth rate remains constant.

Percent annual natural increase =
(birth rate – death rate) ÷ 10

$$\frac{27 - 9}{10} = 1.8\ \%$$

Doubling time (in years) =
70 ÷ rate of increase

$$\frac{70}{1.8} = 39 \text{ years}$$

(Note: 70 is the approximate equivalent of 100 times the natural log of 2.)

Procedure:

Part 1: On the Double

Distribute copies of Student Worksheet 1 and have students complete the table.

Answers To Table:

Annual Natural Increase	Doubling Time (Years)
0.8%	88
2.3%	30
0.3%	233
0.2%	350
1.4%	50
2.1%	33
3.9%	18
0.8%	88
2.7%	26
0.1%	700
0%	no doubling

Discussion:

1. Why do you think some countries are doubling much more rapidly than others? Why do you think some countries, such as Denmark, have reached zero population growth (z.p.g.)?

A. Some countries' populations are doubling very rapidly because couples tend to have larger families, thus causing a birth rate that is much higher than the death rate. Denmark has stabilized its population with the aid of comprehensive family planning programs and a willingness among young people to have smaller families.

2. Which figures differ most greatly between countries, the birth rates or the death rates? How would you explain the wide disparity in birth rates among different countries? Why are the death rates relatively low in many of the countries with high birth rates?

A. The birth rates differ greatly due to differences in average family size. Death rates are relatively low in many of the countries with high birth rates because the majority of the population is young. In Kenya, for instance, 50 percent of the population is under age 15, and only two percent is age 65 or older.

3. If you were a national leader in Kenya, would you be concerned about the rapid population growth? Why or why not? Similarly, if you were a national leader in Denmark, would you be concerned that your country has reached z.p.g.? Why or why not?

A. Yes. As a national leader of Kenya, you would be responsible for seeing that there are sufficient services for the expanding population such as homes, roads, jobs, health care, etc. You would find it difficult for your country to prosper in the world market, if it cannot meet the needs of its own people. As a national leader of Denmark, you would not be faced with these problems and could plan for your nation's future progress.

4. The population of the United States is actually growing at the rate of 1.2 percent each year, significantly more than its rate of natural increase. Where is the additional population growth coming from?

A. Immigration accounts for roughly 30 percent of population growth in the United

States. In recent years, the greatest number of new Americans have come from the following countries: Mexico, Philippines, South Korea, Cuba, Vietnam, India, Dominican Republic, mainland China and Jamaica.

Part 2: Grim Reaper's Revenge

We are currently adding 95 million people (net growth) to the world each year, or 255,000 people each day. Conveying the importance of such figures to students can be difficult since the numbers are so large they lose their meaning. The table in Student Worksheet 2 makes these numbers more concrete by illustrating that the numbers of people lost in history's major disasters are currently being replaced in a matter of days or weeks.

Have students complete the table in Student Worksheet 2.

Answers to Table:

0.8 days
2.4 days
3.5 days
10.1 days
11.7 days
3.6 weeks
5.3 weeks
2.8 weeks – 2.6 months
2.7 months
4.6 months
9.8 months

Demographic Facts of Life

Student Worksheet 1

On the Double

Using the table below, determine the percentage of annual increase and the population doubling times for each country.

$$\text{Percent annual natural increase} = \frac{\text{birth rate} - \text{death rate}}{10}$$

$$\text{Doubling time (in years)} = \frac{70}{\text{rate of increase}}$$

Country	Birth Rate in 1991 (per 1,000 people)	Death Rate in 1991 (per 1,000 people)	Annual Natural Increase	Doubling Time (years)
United States	17	9		
Mexico	29	6		
Japan	10	7		
United Kingdom	14	12		
China	21	7		
India	31	10		
Kenya	46	7		
U.S.S.R.	18	10		
South Africa	35	8		
Italy	10	9		
Denmark	12	12		

Demographic Facts of Life

Student Worksheet 2

Grim Reaper's Revenge

We are currently adding 95 million people (net growth) to the world's population each year. This means we are adding 255,000 people each day. Even the deaths from large-scale disasters have little effect on a population growing so rapidly. Below is a listing of some of the world's worst disasters, along with an approximate death toll. At today's present rate of growth, determine how many days, weeks or months it would take to replace those people lost. Round off to one decimal place.

Some Past Disasters	Approximate # of deaths	Present world population growth replaces this # in what time span?
Bangladeshi cyclone, 1991	200,000	
Total American deaths in all wars	600,000	
Great flood, Hwang Ho River, 1887	900,000	
Total U.S. automobile deaths through 1989	2,600,000	
Indian famine, 1769-70	3,000,000	
All major global disasters as of 1988[1]	6,500,000	
Chinese famine, 1877-78	9,500,000	
Present global famine	5,000,000 to 20,000,000	
Influenza epidemic, 1918	21,000,000	
Global deaths in all wars in the past 500 years	35,000,000	
Bubonic plague, 1347-51	75,000,000	

[1] This includes deaths from all recorded major earthquakes, avalanches, volcanic eruptions, tornadoes, floods, typhoons, fires, explosions, shipwrecks, and railroad and aircraft accidents through 1988.

Casualty figures obtained from the World Almanac *(New York: Newspaper Enterprise Associates, 1988),* Information Please Almanac *(New York: Houghton Mifflin Company, 1989), and the National Highway Safety Administration.*

Population Scavenger Hunt

Student Activity 5

Concept: Population affects nearly every environmental and social concern facing humankind.

Objective: Students complete a wide variety of activities which illustrate the many areas involved with population, the environment and social issues.

Subjects: All

Skills: Vary according to each of 35 tasks

Introduction:

This scavenger hunt encourages students to further investigate many of the concepts introduced in this curriculum. We recommend that you give students time to gather a variety of items from the list, anywhere from a week to a month. Ideally, this would be a good activity to have running during the duration of a unit on population.

Procedure:

Students can work individually or in groups to collect as many items as possible on this list. Since some items involve more work than others, points are assigned to designate degree of difficulty.

1. Collect three newspaper clippings about an environmental or social problem that relates to overpopulation. Write a summary of each article, explaining the link to population growth. *8 points. (1 extra point for each additional article, up to 5.)*
2. Make a poster showing the many effects (environmental, economic, social, etc.) of more people. *5 points.*
3. Watch a news show or special program discussing population, the environment, hunger or poverty. Write a brief summary of the show, stating at least five new facts you learned about the issue. *5 points.*
4. Write an article about population growth and its effects and submit it to the school or community paper. (Or write a letter to your Congressional representatives, telling them how you feel about the issue.) *10 points.*
5. Write a public service announcement about the environmental health risks of ozone layer depletion. *4 points. (5 extra points for performing it in front of the class or 10 extra for making a video of the announcement.)*
6. Make a map of the world depicting the hole(s) in the ozone layer. *4 points.*
7. Graph world temperatures as far back as you can. Write a paragraph explaining the phenomenon of global warming and whether the trend appears on your graph. *5 points.*
8. Contact the Environmental Protection Agency, or the equivalent state or local agency, about whether your city meets the national standards set for air pollution. Report your findings in writing. *5 points.*
9. Using pH paper, test a local lake, stream and drinking water for acidity levels. Turn in the pH paper and an explanation of its meaning. *10 points.*
10. Research the amount of arable land in the world. Using a map, designate the areas with fertile land. *5 points.*
11. Organize a canned food drive to help feed the hungry in your area. Record the number of cans collected and the group which received the food. *20 points.*
12. Chart your personal diet for a week. Put a star next to all of the items which came from the top of the food chain. Circle all of those you could have substituted with something lower on the food chain and write the substitution. *10 points.*
13. Make a collage or mobile using pictures or photographs of the rainforests. *6 points.*
14. Make snack food using mostly rainforest products (include your recipe.) *5 points.*
15. Plant a tree in your community. *10 points. (10 extra points for organizing an event where a group plants trees on a certain day.)*
16. Find out rates of deforestation and reforestation in the United States. Chart or graph these rates and superimpose a population growth chart for the United States. *10 points.*
17. Monitor your household waste generation for a week. Chart your findings, including a list of the items most frequently found in your garbage can. Put a star next to those that could be recycled or composted. *10 points.*
18. Research home composting, and then start a compost pile at home. Take photographs of the system and include a written description of the progress of the compost. *20 points.*
19. Make a poster showing various recyclable items and then the new materials they become after recycling. *6 points.*
20. Create a list of ways to reuse the following items: a shoe box, an unmatched sock, a

coffee can and/or lid, a toilet paper tube, a milk carton. *1 point for every 3 ideas.*

21. Write an investigative report about a threatened species, explaining how human habits have contributed to the species' decrease in numbers. *10 points.*
22. Visit the zoo nearest you and record which animals are considered endangered. If possible, record how many are estimated to be in existence in the wild and in captivity. *10 points. (1 extra point for each drawing or written description of the animals.)*
23. Develop a campaign to save an endangered species of your choice. Design posters, buttons, bumper stickers, etc. *5 points.*
24. Make a rough design of a house dependent only on alternative energy (no fossil fuels). *8 points.*
25. Make a graph showing the per capita energy use of six different countries (three industrialized countries and three less developed countries). *5 points.*
26. Do an energy audit of your home. A local power company may be of assistance. Check the meter and bills to determine how much energy your family uses. *5 points.*
27. Get to school without depending on a motorized vehicle. *1 point for each day.*
28. Research the latest technology for non-fossil fuel powered cars. Make a chart showing the advantages and disadvantages of each. *8 points.*
29. Chart how the Unites States spends money to help the poor in this country. *5 points. (3 extra points for also charting local money spent.)*
30. Find out the number of homeless or unemployed in your community. Explain how you found this information. *5 points.*
31. Make a chart or diagram illustrating how poverty can affect the environment. *5 points.*
32. Interview a woman from a less developed country. Write a report based on her observations of the differences between the role of women in the United States and in her home country. *10 points.*
33. Conduct a survey in your community to determine the average family size. Graph your results. *10 points.*
34. Conduct a survey among classmates to determine how many children, on average, they wish to have. Chart the results. *5 points.*
35. Make up your own activity related to population growth and its environmental and social effects. *Points will be determined by the teacher.*

Climate Change

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Endless Summer: Our Global Future?

Student Reading

If we do not act now to reverse the atmospheric trend known as global warming, we may be vacationing in Nome, Alaska by the mid-21st century. The gases our industrial world has spewed into the atmosphere for decades are turning our planet into a global greenhouse, and scientists are warning that society must take immediate action to avert disastrous consequences.

The Greenhouse Effect

The Earth's atmosphere is a complicated system of gases and energy. It allows sunlight to pass through to the Earth, but not all of it. The ozone layer which surrounds the Earth filters some out, particularly harmful ultraviolet light, reducing the intensity of sunlight upon plants, animals and oceans. Part of the sunlight is transformed through photosynthesis. Some heats the air and water. The rest is reflected back into space.

The Earth's protective ozone layer is under attack by certain gases which human activities are adding to the atmosphere. This is increasing the dangerous ultraviolet light reaching the Earth, which is known to cause cancer and eye disease.

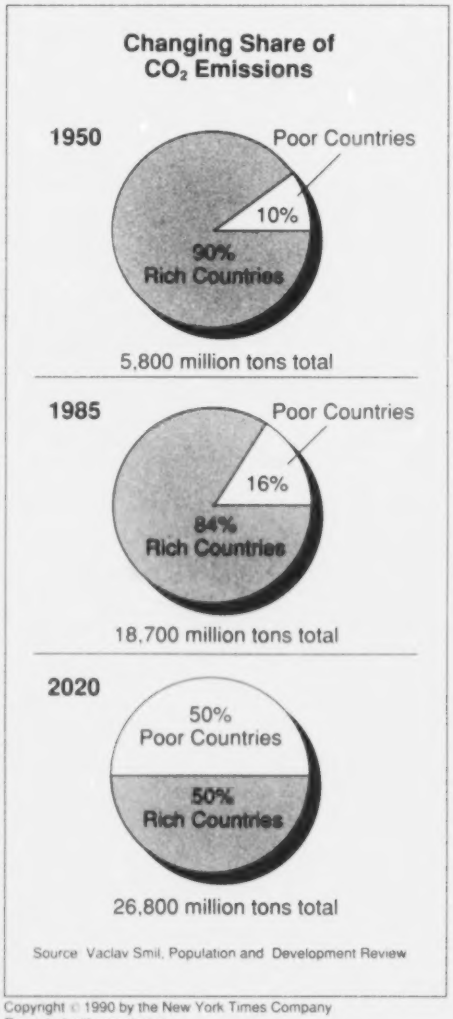
Most of the gases which human activities are adding to the atmosphere are acting like a blanket. They trap the energy which would normally be reflected back into space. This increases the energy load of the atmosphere and heats the Earth. The process works much the way a greenhouse would, hence the name, "greenhouse effect."

The atmosphere and the Earth interact in complex ways, and it is the complexity which makes the balance so easy to disturb. As human activity adds carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxides to the atmosphere, its balance is being upset.

Turning Up the Heat

For tens of thousands of years, the levels of oxygen, nitrogen, and other gases in the Earth's atmosphere remained essentially unchanged. By the beginning of the 19th century, the world's population had grown to one billion, and the Industrial Revolution in North America and Europe was starting to clear the land and taint the air with factory smoke. A century later, the population had doubled to two billion and the age of petroleum was dawning. After the Second World War, energy use skyrocketed. Between 1946 and 1968, the use of motor fuel doubled, electricity consumption nearly tripled, and the production of petroleum-based plastics increased ten-fold!

As a result of increased industrialization and combustion of fossil fuels, more and more carbon dioxide (CO_2), the primary greenhouse gas, has been emitted into the atmosphere. Since 1900, the concentration of CO_2 has increased by more than 20 percent, and mean global temperature has increased by



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one degree Fahrenheit. In the United States, nearly all CO_2 emissions come from three sources: petroleum, coal and natural gas. These fuels power our automobiles, heat our homes, provide electricity for our appliances and allow us to enjoy a standard of living unprecedented in history. Due to this high standard of living, the United States produces nearly 20 percent of world carbon dioxide emissions annually, although we comprise only five percent of the total world population.

St. Joseph Gazette, December 14, 1983.

Two-thirds of all people in less developed countries depend on wood for heating and cooking. Firewood as an energy source is also an important part of the global climate equation. Not only does wood burning add to the load of greenhouse gases, but it also contributes to deforestation. Today, over one billion people are cutting wood for fuel faster than it is regrowing, and by the year 2000 nearly three billion people will lack an adequate supply of firewood. Left growing, forests remove CO_2 from the air through the process of photosynthesis. Cut down and burned or left to rot, the vegetation releases CO_2 instead.

Other Gases

Human activity is also directly related to the production of methane, another greenhouse gas. Methane is released by natural gas leaks, coal mining, oil and gas drilling, burning of wood and garbage, and the decomposition of inorganic matter in rice paddies and the intestines of cattle, sheep and termites. Worldwide production of methane is expected to increase as more cattle are raised and more rice is cultivated to feed increasing numbers of humans. Although methane accounts for a smaller part of the greenhouse gas volume (18 percent) than does CO_2 (49 percent), it is potentially more dangerous. Each methane molecule is 30 to 40 times more efficient at trapping heat than a CO_2 molecule. Further, methane lifetime in the atmosphere is from five to ten years, and levels are rising up to one percent annually.

Ounce for ounce, chlorofluorocarbons (CFCs) are the most destructive of the greenhouse gases. They are 10,000 to 20,000 times more effective at trapping heat than CO_2, and have an atmospheric lifetime of 75 to 400 years. Completely human-made chemicals, CFCs are used as refrigerator and air conditioner coolants, as chemical cleaners, in the manufacturing of foam and in aerosol spray cans. CFCs are not only accelerating greenhouse warming, but are also depleting ozone in the upper atmosphere.

Other greenhouse gases include nitrous oxide (N_2O) and tropospheric ozone (O_3). Also known as "laughing gas," nitrous oxide is a byproduct of fossil fuel combustion, bacterial reaction in soil and the breakdown of widely used fertilizers. Although ozone is a natural part of the atmosphere, it contributes to warming when it is formed at lower elevations. Its formation is catalyzed by several other gases, particularly nitrogen oxides and carbon monoxide.

All of the gases added to the atmosphere by energy use are responsible for over half of the increase in global temperatures. The trends point to increased energy consumption in the future, particularly in the developing world where the population is expected to double in just 33 years. Daniel J. Evans, chair of the National Academy of Sciences panel on global warming, stated in 1991 that population

growth, "is the biggest single driver of atmospheric pollution."

A Price for Progress

Potential changes in the average temperature of the Earth from 1.5 to as much as 10 degrees Centigrade pose a wide range of consequences, from regional crisis to global catastrophe. Some of the possible consequences of global warming are as follows:

- Sea levels may rise by three to five feet or more, flooding low-lying areas where much of the world's population lives.
- Droughts may occur more often and with greater severity, turning larger areas of cropland into desert.
- Deforestation may accelerate as temperatures change faster than most species of trees can tolerate.
- Tropical diseases and pests may spread, with devastating effects upon stressed crops and malnourished populations.
- Monsoons and hurricanes may increase in severity, bringing with them greater devastation and death.
- Extinction of plant and animal species may accelerate, with whole populations of species being decimated by changes in habitat, food sources and temperatures.
- Crops may fail as temperate zones push northward and the soils fail to support them.

How Much, How Fast?

A degree of uncertainty remains as to the timing and severity of global warming. However, there is no uncertainty that the levels of carbon dioxide and methane are increasing rapidly and warming the globe. It is no coincidence that the six hottest years in recorded history have all been since 1980. The U.S. Environmental Protection Agency (EPA) projects a change in the average global temperature of 2.0 to 6.0 degrees Centigrade, but does not rule out the possibility of even greater warming.

Cool It!

Scientists concur that global warming is a threat sufficient to justify immediate action. Every year of delay only contributes to the problem. Reducing the threat of global warming must begin with a rapid reduction in CO_2 emissions. This can only be accomplished through a combination of increased energy conservation, increased energy efficiency and increased usage of alternate and renewable energy sources. The EPA estimates that to stabilize atmospheric concentrations of CO_2 at current levels, carbon emissions must be cut by 50-80 percent.

Successful efforts to slow population growth would allow nations to cut CO_2 emissions more easily. Many experts believe that a program with any chance of success must be aimed at both resource consumption and population stabilization.

Reducing deforestation, while planting and cultivating new forests, would absorb CO_2 and preserve the biological richness of our planet. As far as other greenhouse gases are concerned, CFCs, in particular, must be eliminated as rapidly as possible due to their dual contribution to global warming and ozone depletion. International efforts to reduce use of CFCs is already underway. Under the Montreal Protocol, effective in 1989, 31 countries agreed to reduce production and consumption of CFCs by one-half by the year 1999.

There is hope for slowing the warming trend. To meet this challenge will require international cooperation, responsible national leadership and individual action.

An International Greenhouse

Student Activity 6

Concept: The Earth's atmosphere knows no national boundaries. Global cooperation is imperative if we hope to reverse present climate trends.

Objective: As representatives of member nations in a model United Nations simulation, students will attempt to draft resolutions addressing global warming and ozone layer depletion. In doing so, they will learn about the causes and effects of global climate change and the need for international cooperation to address this trend.

Subject Areas: Social studies, language arts, environmental science, biology

Skills: Public speaking, research, conflict resolution, negotiation, parliamentary procedure

Materials:

Placards for each country on the Governing Council of the United Nations Environment Programme (UNEP)

Copies of "Delegate Briefing Paper"

Model U.N. Survival Kit is optional, but recommended. Updated annually, the kit includes: "A Guide to Delegate Preparation," "Basic Facts About the United Nations," "Issues Before the General Assembly of the United Nations," "The U.N. Charter," and information on how to prepare for a Model U.N. The *Model U.N. Survival Kit* is available from the United Nations Association of the U.S.A., 485 Fifth Avenue, New York, NY 10017; 212/697-3232. The complete kit is available for $24.00, but kit components may also be purchased separately.

Procedure:

In order to focus the U.N. simulation on issues of climate change, the students will represent only those 58 nations which comprise the Governing Council of the United Nations Environment Programme (UNEP).

1. Duplicate the briefing paper, "The U.N. and Global Climate Change," for each student.
2. Assign each student a member nation to represent from the list provided at the end of this activity. Either combine two classes so that each of the 58 nations are represented or only use half of the countries for one class. If you use only half of the countries from the list, be sure to include a fair representation from each continent. You may wish to team-teach this activity with an instructor from a different discipline, since this activity lends itself to an interdisciplinary approach.
3. Allow students several days to thoroughly research the nation they will represent. In preparing for the simulation, students should be well-versed on the history, culture, economy, demographics, geography and past international relations of their countries. Have students make full use of library resources, including world almanacs, atlases, other books, periodicals and newspaper clippings. You should expect that some students will find more resources on their assigned countries than others. Students should also be aware of specific consequences to their nations of continued climate change (see "Delegate Briefing Paper").
4. If possible, prepare background reading for the students on the issues to be addressed by the delegates. In addition to the information on global warming and climate change already provided, you may wish to provide students with any other useful articles on the issues. It may also be helpful to brief students on prior U.N. actions on climate change issues. This information is available from the U.N. directly, and is also chronicled in the *Model U.N. Survival Kit*.
5. Train students in the rules of procedure for the simulation. All U.N. bodies conduct business according to specific rules of procedure, even though they also function through informal channels. model U.N. conferences usually adapt U.N. rules and procedures to fit time and other constraints. You may wish to adapt "Robert's Rules of Order" for use in the simulation. Some of the more common model U.N. rules of procedure are included in this activity. The less formal procedures of bloc politics and political interaction should also be incorporated into your simulation. A "bloc" is a group of persons or nations that forms a political unit with a common interest or purpose.
6. Select or have the council select a chairperson to lead the meetings. The chairperson should be well acquainted with the group's rules of procedure.
7. Arrange desks in a way that is most conducive for debate in your classroom or auditorium. Have each student prominently display his or her country placard.
8. The council's first meeting should open with general debate on the issue of global warming and what should or should not be done to combat climate change. This session will allow nations to articulate their broad policies and goals for the session. It provides a mechanism for the initial development of common goals between nations and interest groups.
9. After this initial meeting, delegates should break to draft proposals and resolutions. Students should seek out delegates with similar views and national interests on the issue of climate change. Caucusing and negotiation are fundamental to any model U.N. simulation. These intra- and inter-bloc meetings will ultimately produce the resolutions and proposals which will be formally considered by the council. Informal bloc meetings, which form in the hall or corner to draft a resolution, discuss potential compromises or mobilize the needed majority, are often the real work of the U.N. For help in drafting resolutions, you may wish to obtain "A Guide to Delegate Preparation" (included in the *Model U.N. Survival Kit* or available separately from the United Nations Association). You may want to restrict resolution writing to one class period.

10. In the next meeting of the council, delegates or groups of delegates will offer their proposals and a period of substantive debate on these proposals will ensue. You may wish to put a time limit on this debate. After the debate period, delegates should vote on the resolutions at hand. Resolutions or amendments can be adopted with a majority vote.

Follow-up Activity:

At the time this activity was developed, U.N. delegates were preparing to convene in Brazil for the United Nations Conference on the Environment and Development (UNCED) in June 1992. One of the expected goals of UNCED was the ratification of a global treaty on climate change.

Have students find out more about UNCED. What preparations on climate change were needed before delegates could convene? If UNCED has already taken place, what was the outcome? How do these resolutions compare to the ones developed in class?

COMMON RULES OF PROCEDURE

Procedural Motions: Actions of the body that determine how a topic is discussed and how resolutions are decided by the body. Common procedural motions (in order of importance) include the following:

1. To adjourn the meeting/session.
2. To suspend the meeting/session.
3. Point of order, information, and/or personal privilege.
4. To adjourn debate on an item (to "table" a resolution or item).
5. To close debate on an item, resolution or amendment.
6. To limit debate on an item, resolution or amendment.
7. To reconsider an item, resolution or amendment.

Substantive Motions: Actions of the body in the form of resolutions, amendments or decisions. Common substantive motions include the following:

1. To consider a resolution.
2. To consider an amendment.
3. Interventions made by delegates on 1 and 2 (e.g., speeches, statements, etc.).

MEMBER NATIONS OF THE UNEP GOVERNING COUNCIL (as of 1989)

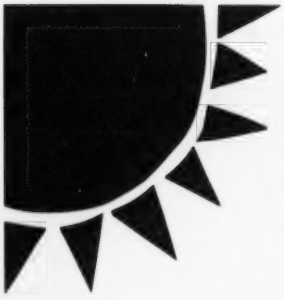
Argentina
Australia
Bangladesh
Barbados
Botswana
Brazil
Bulgaria
Burundi
Canada
Chile
China
Colombia
Costa Rica
Côte d'Ivoire
Czechoslovakia
Dominican Republic
Finland
France
Gabon
Germany
Greece
Guyana
India
Indonesia
Iran
Iraq
Japan
Jordan
Kenya
Lesotho
Libyan Arab Jamahiriya
Malta
Mauritania
Mauritius
Mexico
Netherlands
Oman
Pakistan
Poland
Republic of Korea
Rwanda
Saudi Arabia
Senegal
Sri Lanka
Sudan
Sweden
Switzerland
Togo
Turkey
Uganda
Ukrainian Soviet Socialist Republic
Union of Soviet Socialist Republics
United Kingdom of Great Britain and Northern Ireland
United States of America
Venezuela
Yugoslavia
Zaire
Zimbabwe

Rules about voting include:

1. The order in which recorded votes are taken.
2. The number of votes required for adoption of resolutions or amendments [this could be a simple majority (50 percent plus 1 of the members present and voting) ***or*** two-thirds majority].
3. Division of the question (taking each section of a resolution or amendment and voting separately on each).
4. A non-recorded vote or a hand vote.
5. The order of amendments to be voted on when multiple amendments to a resolution are permitted (usually the body is required to begin with the amendment furthest removed from the substance of the resolution and handle them consecutively until all the amendments have been dealt with).

An International Greenhouse

Delegate Briefing Paper



The U.N. and Global Climate Change

"As the cold war recedes, the environment is becoming the #1 international security concern," noted scientist Michael Oppenheimer [*New York Times,* 3/27/90]. Because issues of the global environment affect every nation in the world, the United Nations has committed itself to work toward international solutions to critical environmental problems.

Climate change is a global problem that demands a global solution. No one nation is solely responsible for global warming and ozone depletion, and no one nation can stop the momentum of the changes. If the present climate changes are to be reversed in order to avoid global catastrophe, all nations must work on cooperative solutions.

In 1972, the General Assembly of the United Nations created the United Nations Environment Programme (UNEP) to monitor the environment and to encourage and coordinate sound environmental practices. UNEP's main job is to catalyze environmental action and awareness worldwide.

In recent years, the international community has become increasingly concerned about global climate change. To define the most comprehensive assessment of global warming and climate change, UNEP and the World Meteorological Organization established the Intergovernmental Panel on Climate Change (IPCC) in 1988 to study the science and impacts of climate change, and to recommend possible policy responses. Several hundred scientists from 35 countries participated in the IPCC study.

The IPCC concluded that "the greenhouse gases already emitted as a result of human activities have committed the world to an unprecedentedly rapid warming. Earth is now 0.5 degrees Celsius warmer than in preindustrial times, and by the end of the next century we can expect it to be at least three degrees warmer. If we do not act soon to reduce emissions, the best we can expect is that within a century, the world will be warmer than at any time since the start of agricultural civilization six thousand years ago" [UNEP, 1991].

The IPCC's report cited numerous climatic and health effects of continued warming, including rising sea level resulting in flooding of delta areas, changing rainfall patterns and increased health risks. Based on these findings, the IPCC recommended immediate and drastic reductions in carbon dioxide emissions (60–80 percent), a reduction in methane emissions (15–20 percent), as well as early implementation of the phase-out of chlorofluorocarbons and more research into ways of reducing nitrous oxide.

Actions to combat global warming are complex, difficult and expensive. Although nations may agree that global warming must be reversed, leaders find it difficult to agree on a plan of action which is equally beneficial to all countries.

Competing Interests

We live in a demographically divided world of industrialized nations and less developed nations. These differences in standards of living shape perspectives on appropriate actions to stem climate change.

Developed and developing nations often conflict over the economic ramifications of protecting the environment. One camp says that poverty causes environmental destruction and that a crash program to bring Western-style development to poor nations is the best approach. The other camp says Western-style development is the problem.

Today the United States, comprising five percent of the world's population, produces nearly 20 percent of all human–made atmospheric carbon dioxide, and uses more energy relative to its economic size than any western country except Canada. Any world policy to tackle global warming will mean a radical reduction in and restructuring of U.S. energy consumption, and will require hard political and economic decisions.

This is not to say that the problem is just a North American one. Although the industrialized world emits 75 percent of all greenhouse gas emissions arising from human activity, their emissions are now increasing at a rate of less than one percent each year. In contrast, less developed countries, where 75 percent of the world's population lives, are increasing their emissions at a rate of six percent a year. As the population grows by 87 million people a year in less developed countries, demand for fossil fuels also grows.

"If developing nations continue their present path toward greater economic expansion, installing the same polluting technologies

that made industrialized nations rich, their contribution towards global warming will soon outstrip that of industrialized nations. Even if the industrialized world were to completely stop all emissions of greenhouse gases, global warming would continue to accelerate" [UNEP, 1991].

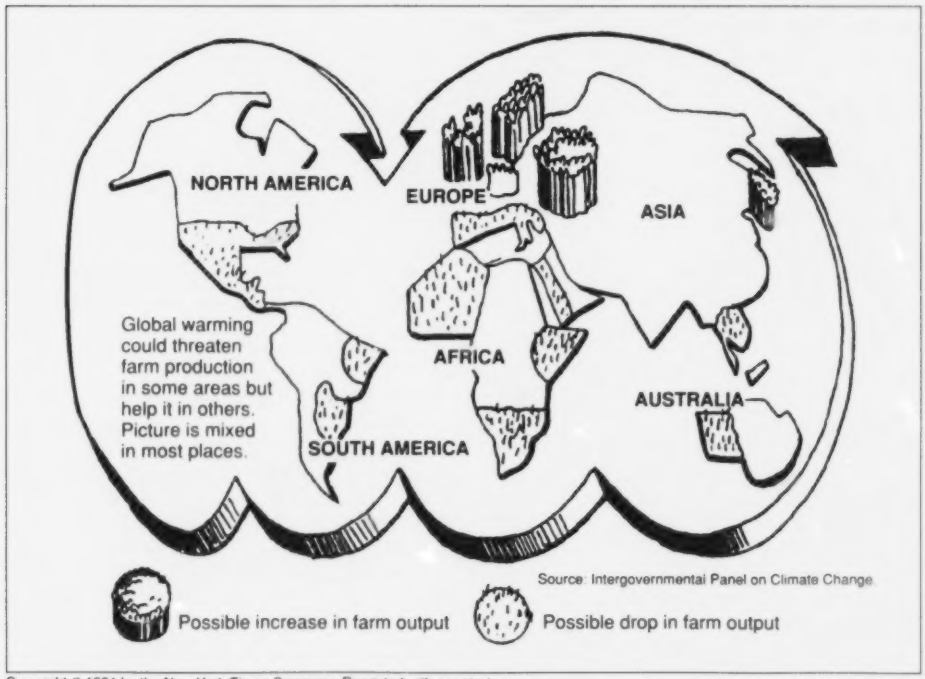
Clearly, much negotiation is required to arrive at solutions to global warming which meet the basic needs of all nations. But as Benjamin Franklin said, "We will hang together or assuredly we will hang separately."

Global Warming: Who Stands to Lose the Most?

Every corner of the world will feel the effects of global warming, but less developed countries will be hardest hit by the negative consequences since they do not possess the financial and technical resources to adapt to the climate changes that could result in rising sea levels, increasing incidence of drought and floods, and greater frequency of savage storms.

Scientists are already speculating as to which nations will stand to lose the most by an increase in atmospheric temperature. In Southern Europe, the United States, Central America, parts of South America, Africa and Southeast Asia, crop yields and livestock production may drop dramatically. In the humid tropics, where much of the world's rice harvest is produced, it is thought that the Southeast Asian monsoon may intensify, bringing more rain in summer and possibly less in winter. Shortfalls in food production in these areas could be balanced by production increases in higher latitudes, particularly in the northern hemisphere. This may produce more favorable agricultural conditions in Canada, the U.S.S.R. and Scandinavia.

Due to the expected rise in sea level, unprotected delta areas will be flooded. Millions of Bangladeshis will lose their homes, while nations such as Egypt, China, Indonesia and India could lose important tracts of productive land to flooding. With the world's oceans calculated to rise about 65 cm by the end of the next century, some 300 Pacific atolls could disappear and the existence of several island nations in the Pacific and Indian Oceans and in the Caribbean could be threatened.


NORTH AMERICA
EUROPE
ASIA
AFRICA
AUSTRALIA
SOUTH AMERICA
Global warming could threaten farm production in some areas but help it in others. Picture is mixed in most places.
Source: Intergovernmental Panel on Climate Change
Possible increase in farm output
Possible drop in farm output

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Methane and You

Student Activity 7

Concept: Production of methane, a greenhouse gas, can be linked directly to human activity.

Objective: Students will study possible relationships between several human activities and methane production.

Subjects: Biology, chemistry, environmental science, math

Skills: Data analysis, diagraming, graphing

Materials:

Copies of Student Worksheet
Graph paper

Procedure:

Distribute copies of the Student Worksheet and allow students about 30 minutes to work through the questions and graphing exercises, either individually or in groups. Go over answers in remaining class time.

Suggested Answers to Student Worksheet:

1. **Increased:**

   Wetlands – crops like rice paddies and cranberries

   Cattle – due to meat eaters

   Forest and grass burning – for land to grow food and graze cattle

   Mining and natural gas – demand for goods mined and need for fuel (natural gas)

   Landfills – increasing amount of waste

   Termites – termite population increases from deforestation

   Lakes – more dams for electricity

   Decreased:

   Wetlands – from humans draining them for other uses

2. It will probably escape into the atmosphere.

3. Increased human population → need for agricultural land area → deforestation → broken wood, dead roots → increased termite population → wood-digesting microorganisms → methane as a digestive waste → increased atmospheric methane.

4. Since methane is produced when plant material is decomposed without the presence of oxygen, the bubbles are methane escaping throughout the water.

5. The melting of the frozen water will release the methane into the atmosphere.

6. a) Both are increasing.

   b) Human population growth causes increased methane production.

   c) Very large amounts of people and methane will be present.

   d) Stabilizing population growth and reducing activities which cause methane production (see answers to #1 on the Student Worksheet for examples).

Follow-up Activities:

1. Cattle, goats and sheep emit methane as they digest grass and other fibrous plants. Each head of American beef cattle belches out about a third of a pound of methane per pound of beef it yields. Add the carbon released from fuels burned in animal farming, and every pound of steak has the same greenhouse-warming effect as a 25-mile drive in a typical American car.

   What, if anything, could be done individually or nationally to reduce cattle's contribution to climate change? *Answer: The only solution is to decrease the amount of cattle raised in the United States. Obviously, this would require individuals changing their habits and eating less meat.*

2. In addition to methane (CH_4), other greenhouse gases include: carbon dioxide (CO_2), chlorofluorocarbons (CFCs), tropospheric ozone (O_3) and nitrous oxides (N_2O).

Gas	Source
carbon dioxide (CO_2)	power plants, all fossil fuel burning, deforestation
chlorofluorocarbons (CFCs)	refrigerant, insulation foams, aerosol propellant, industrial chemicals
tropospheric ozone (O_3)	natural part of ozone atmosphere but concentration increasingly due to increases in carbon monoxide
nitrous oxides	ammonia- and urea-based fertilizers, natural microbial soil activity, spread of agriculture, burning of timber, crop residues and fossil fuels

   Explain the links, if any, between human population growth and the increase in levels of each of these greenhouse gases. *Many answers are possible.*

Adapted with permission from the Climate Protection Institute. The original activity, "Human Activity and Methane Production," appears in Global Warming Activities for High School Science Classes *by Dorothy Rosenthal and Richard Golden, Climate Protection Institute, Oakland, CA, 1991.*

Methane and You

Student Worksheet

Introduction:

Methane, our most abundant hydrocarbon, often called natural gas, is a very efficient absorber of infrared radiation. Although its present atmospheric concentration is only 1.68 parts per million, its high rate of increase is a cause of concern. If, as expected, the atmospheric concentration of methane doubles in the next 30 years, the cumulative warming effect of methane and the other trace greenhouse gases will equal that of carbon dioxide.

Ice bubble analysis has shown that methane concentration held steady for the last 10,000 years. About 300 years ago the level began to rise and 100 years ago it began to soar. The current annual rate of increase of methane (1 percent) is greater than that of carbon dioxide (0.4 percent).

There is no clear consensus among scientists about why the concentration of methane is rising so rapidly. Much of it comes from the breakdown of plant material in the absence of oxygen, as in swamps and inside cattle. However, much methane is also produced through certain human activities which have increased as the human population has grown.

Methane Facts and Questions:

1. Below is a list of sources of methane in order of volume produced, highest to lowest:
   - wetlands, swamps
   - cattle
   - tropical rainforest and grass savanna burning
   - natural gas and mining
   - human-made dumps, landfills
   - termites and other insects
   - oceans
   - lakes
   - tundra

   Which of the above have increased because of human activities and/or human population growth? Have any decreased with human activity? Explain your answers.

2. The natural gas that we burn in our homes for heating and cooking is about 90 percent methane. It has been released by drilling into trapped underground pockets of gas.

   What happens to the methane that escapes in the drilling or in pipe leakage while being transported to our homes?

3. Microorganisms capable of digesting wood live in the guts of termites. One of their waste products is methane. As deforestation has continued around the world, the supply of rotting wood has increased. This abundant food source has expanded the termite population. A significant part of the increase in atmospheric methane is thought to be due to this source.

   Re-order the following statements and then use a flow chart diagram to show how they are related.

   Increased atmospheric methane
   Increased termite population
   Increased human population
   Deforestation
   Need for agricultural land area
   Wood-digesting microorganisms
   Broken wood, dead roots
   Methane as a digestive waste

4. Rice plants are composed of hollow tubes that grow out of waterlogged soil. Methane produced by bacteria in the muck finds its way into the atmosphere through the rice tubes.

   Have you ever seen bubbles rising from the muddy bottom of a lake? What could the gas be and where do you think it came from?

5. The permafrosts of tundra regions and of polar ocean sediments contain vast quantities of methane trapped by frozen water molecules.

   What may happen if, partly due to the increase in atmospheric methane, the environment gets warmer and the frozen water melts?

6. On graph paper, construct a chart with the years 1500–2000 A.D. listed along the horizontal axis, "world population (in billions)" written along the right vertical axis, and "methane concentration (ppm)" written along the left vertical axis. Using the data below, construct two line graphs on your chart: one showing world population growth through time and the other showing the increase in atmospheric methane.

Year	Methane (parts per million)	World Population (in billions)
1500	0.64	0.43
1590	0.66	0.53
1670	0.65	0.58
1750	0.70	0.76
1790	0.78	0.91
1820	0.76	1.05
1850	0.80	1.21
1870	0.84	1.36
1879	0.86	1.44
1915	0.95	1.80
1950	1.15	2.52
1970	1.30	3.70
1979	1.54	4.37
1983	1.60	4.69
1984	1.63	4.77
1986	1.65	4.94
1988	1.68	5.11

Questions:

a. Using the graph, how does the change in human population compare with the change in concentration of methane in the atmosphere?

b. How can you explain the relationship that the two graphs seem to show?

c. If present trends continue, what would you predict for the year 2050?

d. What might change present trends?

Air Pollution

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Gasping for Clean Air

Student Reading

The sky's the limit for the billions of tons of pollutants humans pump out of factories, homes and cars each year. These pollutants create problems such as urban smog, acid rain and toxic gases. Increased global industrialization and rapid population growth are combining to create more of these pollutants, threatening the very air we breathe. The health of humans and that of our ecosystem are suffering as a result of the largely preventable amounts of pollution with which we poison our air.

In many cities, it is actually hazardous to breathe. In the United States, some 150 million people breathe air considered unhealthy by the U.S. Environmental Protection Agency (EPA). Breathing the air in Bombay, India is equivalent to smoking ten cigarettes a day. And in Mexico City, the world's most polluted and populated city, infectious diseases like salmonella and hepatitis can be contracted simply by inhaling bacteria suspended in the air.

Smog Alert

The most severe urban air-quality problem in most regions of the United States is ozone. High in the atmosphere, ozone forms a layer that filters out harmful ultraviolet radiation, thus protecting life on Earth. But ozone is also formed at the Earth's surface, creating ozone pollution, also known as smog. Fossil fuel- burning power plants and industry contribute to ozone pollution, but motor vehicles currently account for almost half of the ozone pollution nationwide. This is not surprising when you consider that Americans own one-third of the world's cars and drive about as many miles as the rest of the world combined. In many rapidly expanding cities, smog levels are on the rise. For example, an 82-city study conducted by the U.S. Public Interest Research Group found ozone pollution from 1980 to 1988 increasing in 39 percent of the cities studied.

The adverse health effects of ozone pollution range from eye and throat irritation, nasal congestion, and coughing to possible permanent damage to lung tissue and breathing capacity. Although many Americans think only a few large cities like Los Angeles have smog problems, ozone pollution pervades every large city, many smaller cities and some rural areas as well. The American Lung Association estimates that 382 counties, home to more than half of all Americans, exceed ozone levels considered safe for humans. They also maintain that the nation spends as much as $40 billion each year in health care costs and lost productivity due to air pollution.

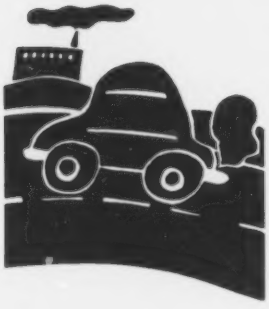
The damage from ozone gas is not limited to its effects on human health. Ozone attacks trees, crops and other plants, reducing growth rates and causing premature death. Forest declines in several parts of the country have been attributed to ozone and other air pollutants. The National Crop Assessment Program estimates that ozone damage to corn, peanuts, soybeans and wheat costs the nation between $1.9 billion and $4.5 billion annually.

The second most pervasive vehicle-related pollutant, behind ozone, is carbon monoxide (CO). In the most heavily populated areas of the nation, vehicle emissions are responsible for up to 90 percent of carbon monoxide pollution. Carbon monoxide is absorbed into the bloodstream more quickly than oxygen, creating numerous health risks. Exposure to even low levels of CO interferes with the body's maintenance of normal oxygen levels, producing impaired perception and thinking, slowed reflexes and drowsiness. Long-term exposure to CO is believed to aggravate arteriosclerosis and cardiovascular disease.

Coal Toll

Other dangerous elements that pollute our planet and threaten our well-being include sulfur dioxide (SO_2), particulates (suspended particles of soot, ash and dust), nitrogen dioxide (NO_2) and lead. Emissions of these elements have been greatly reduced in industrial countries with the aid of pollution-control equipment and improvements in energy efficiency. In much of the world, however, these elements pose dire threats to human and environmental health. In Eastern Europe and the Soviet Union, hasty industrialization after World War II, powered by high-sulfur, brown coal, has led to widespread environmental degradation and human illness. In India, SO_2 emissions from coal and oil have nearly tripled since the early sixties.

Suspended particulate matter also poses a grave threat to developing countries. Diesel-fueled vehicles, lacking even the most basic pollution control devices, emit smoke laden with particulates. The World Health



Organization concluded that nearly 625 million people worldwide are exposed to unhealthy levels of sulfur dioxide, and more than a billion—one in five people in the world—to excessive levels of suspended particulates.

Acid Attack

Excessive levels of pollutants are just as damaging to the planet's health as they are to its inhabitants, especially in the form of acid rain. When sulfur and nitrogen oxides combine with oxygen and moisture in the atmosphere, they become sulfuric and nitric acids. These acidic pollutants fall to the ground, often hundreds of miles from their origins, as dry particles or in rain, snow, frost, fog and dew.

In areas severely affected by acid rain, trees decline in growth and die prematurely, plants and microorganisms crucial to the wildlife food chain die, and lakes become too acidic to support fish and birds. Acid rain has already damaged a full 35 percent of Europe's total forested area. The Environmental Defense Fund revealed that in the United States there are already about 1,000 acidified lakes and 3,000 marginally acidified ones.

Acid rain can also take its toll on the human body. Sulfuric and nitrogen oxide emissions have been linked to increased frequency of asthma, heart disease and lung disease, especially among children and the elderly. Consumption of contaminated fish from acidified lakes can lead to mercury poisoning. Even the water you drink may be tainted. Acid rain can cause a leaching of toxic substances both out of the soil and out of pipes that carry drinking water to millions of people.

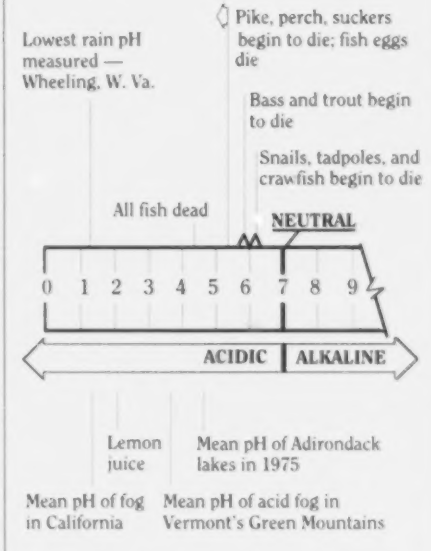
Due to the chemically corrosive nature of acid rain, it eats away at our bridges, buildings and monuments, as well as destroying priceless works of art. It is estimated that Athenian monuments have deteriorated more in the past 20 to 25 years from pollution than in the previous 2,400 years.

Although the causes and effects of acid precipitation have been known for some time, the official U.S. government response has been limited. Several states have acted on their own to require reductions in cause-related emissions. However, because acid rain-producing chemicals know no boundaries, individual states alone cannot solve the problem.

Changing Fuel-ish Ways

The Clean Air Act of 1970 and the strengthening amendments of 1977 directed the EPA to establish air standards for six of the most common and widespread air pollutants. Under the Clean Air Act, state governments were directed to develop and implement strategies to meet and maintain these air quality standards. Considerable progress was made in cutting urban air pollution, especially with the development of the catalytic converter, which removes some pollutants from car exhausts, and the shift to unleaded gas for motor vehicles. Despite this progress, the bulk of pollution that gave rise to the Clean Air Act of 1970 continues. The Conservation Foundation calculates that U.S. emissions of hydrocarbons and ozone, the key ingredients in smog, are still about 80 percent of 1970 emissions.

The pH Scale and Acid Rain


Pike, perch, suckers begin to die; fish eggs die
Lowest rain pH measured — Wheeling, W. Va.
Bass and trout begin to die
Snails, tadpoles, and crawfish begin to die
All fish dead
NEUTRAL
0 1 2 3 4 5 6 7 8 9
ACIDIC
ALKALINE
Lemon juice
Mean pH of Adirondack lakes in 1975
Mean pH of fog in California
Mean pH of acid fog in Vermont's Green Mountains

Sources: "Darkening Skies: The Mounting Air Pollution Crisis in the United States," Sierra Club Report, March, 1989; Canadian Embassy

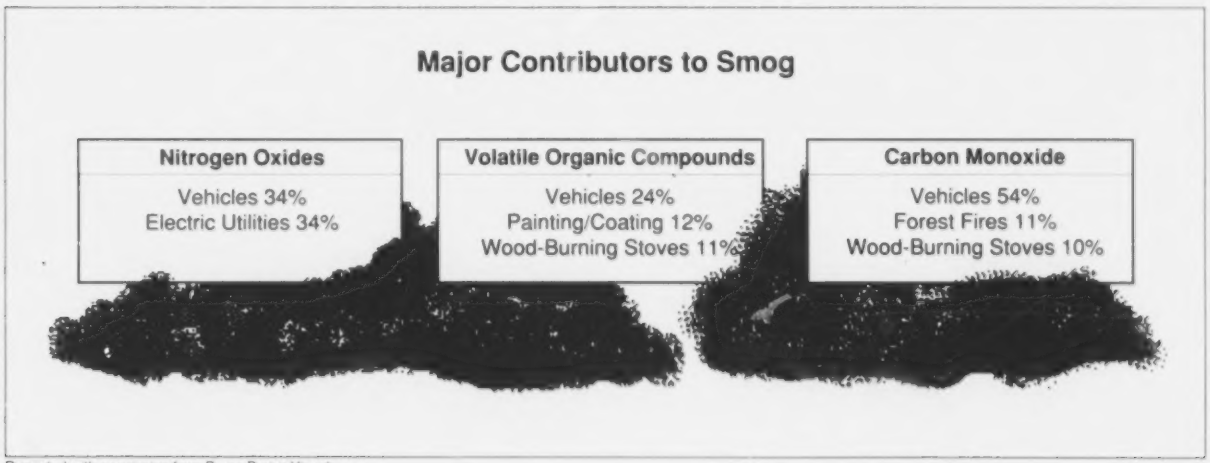
Reprinted with permission from *Greenpeace Action*.

In 1990, Congress approved a new Clean Air Act. The new legislation calls for enhanced car inspection and maintenance programs,

tailpipe regulations, development of cleaner-burning fuels, and a cap on sulfur dioxide emissions from power plants.

Although these measures may allow us to breathe a little easier, the number of air-polluting cars on the road is expected to increase. Over the past 40 years, the United States has added 100 million people to its population who, in turn, have quadrupled the number of cars on the road. Spurred by population growth, vehicle miles traveled in the United States are growing by approximately 25 billion miles per year. The EPA estimates that, over the next 20 years, the 147 million cars now on the road will increase by 76 percent, and the number of miles driven by 60 percent. These trends could offset the overall gains from the new standards set in the Clean Air Act.

Air pollution is undoubtedly a complex problem with no easy, inexpensive, short-term solutions. Development of cleaner fuels, better emission-control technology, strengthened federal fuel economy standards for motor vehicles, and a more efficient mix of transportation alternatives, such as mass transit systems, could all play a significant role in achieving clean air in cities. If current population trends continue, however, it will become increasingly more difficult for Americans to clear the air.



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The Acid Tests

Student Activity 8

Concept: Acid rain, produced by fossil fuel combustion, is detrimental to the growth of many plant species.

Objectives: Students test different pH solutions on radish seeds to determine optimal level for seed germination. They then test the acidity of pond water in their local areas.

Subjects: Biology, chemistry, environmental science

Skills: Lab preparation, data analysis, collection and recording, graphing, measuring, observation, sketching

Materials:

(one set for each lab group)
Copies of Student Worksheet
Petri dish
4 radish seeds
Glass marking pencil
Scissors
Metric ruler or calipers
Graph paper
Absorbent paper towel
Colored chalk or markers
Rainwater
pH paper
Water solution of varied pH (suggested levels: 1,2,3,4,5, 6–different for each group)

Introduction:

Acid rain is something of a misnomer, because rain is naturally acidic, with a pH of about 5.6. When we speak of acid rain, therefore, we refer to rain with a pH lower than 5.6. Acid rain is produced when sulfur and nitrogen compounds are released into the atmosphere, where they combine with water to form sulfuric acid and nitric acids. When coal, oil and gas are burned, large amounts of sulfur and nitrogen are released as gases making the rain more acidic. Acid rain has many effects on an ecosystem. In this investigation, students will examine just one of those effects.

Procedure:

Set-up:

You will need to make the water solutions before class, using 10 percent sulfuric acid (H_2SO_4). If you have not worked with these chemicals before, consult with a chemistry teacher about correct safety procedure. (Note: As you add drops of H_2SO_4, be sure the solution is thoroughly stirred. The number of drops recommended for each solution is approximate, so it is important that you take several pH measurements for each solution.) Use the following recipe:

A. 500 ml. of spring water = pH 6

B. 500 ml. of spring water + approximately 5 drops of 10% H_2SO_4 = pH 5

C. 500 ml. of spring water + approximately 15 drops of 10% H_2SO_4 = pH 4

D. 500 ml. of spring water + approximately 25 drops of 10% H_2SO_4 = pH 3

E. 500 ml. of spring water + approximately 30 drops of 10% H_2SO_4 = pH 2

F. 500 ml. of spring water + approximately 35 drops of 10% H_2SO_4 = pH 1

Activity:

1. Distribute copies of the Student Worksheet and divide the class into six lab groups. Give each group a set of materials as listed above. Be sure to label each pH solution and assign a different pH (from 1 to 6) to each group.
2. On Day 1, students will set up the experiment according to directions in Part A of the Student Worksheet. On Days 2-10, students will observe and record findings as indicated in Part B.
3. While students are completing their experiment, set up a petri dish with radish seeds and rainwater. Record these results with those of the students on the class graph. Have students answer the worksheet discussion questions and supply rainwater samples for students to check their guesses. Discuss the answers with the whole class.

Follow-up Activities:

1. More advanced students can mix their own solutions for testing. They can also experiment with different kinds of acids (sulfuric, nitric, etc.) and levels. Of course, proper safety procedures have to be strictly observed. Also, each group could have several dishes to observe, to compare and graph the results.
2. Have students test samples of lake or pond water and soil with pH paper in their local areas to determine levels of acidity. They can then compare their findings to those of their classmates who collected samples from different sources.
3. Plants are not the only organisms affected by acid rain. Have students list ecosystems that are negatively affected by acid precipitation. What might be the long-term effects of acid rain for these areas?

Adapted with permission from Biological Sciences Curriculum Study (BSCS). The original activity, "The Effects of Acid Rain on Seed Germination," appears in Biological Science: An Ecological Approach, BSCS Green version *(Kendall-Hunt Publishing Company, 1987).*

The Acid Tests

Student Worksheet

PART A - Day 1

1. Cut four paper discs the size of the petri dish from an absorbent paper towel.
2. Dampen the paper discs with the water assigned to you by your teacher. Use pH paper to test the pH of your assigned water and note the pH in your data book.
3. Place two of the paper discs on the bottom of the petri dish.
4. Measure the length of your four seeds and determine the average length.
5. Record the average length in millimeters at Day 1 in your data book.
6. Arrange the seeds in the petri dish and cover with the two remaining discs. Make sure the discs are still moist. If not, add more of your assigned pH solution.
7. Replace lid on petri dish and label both the lid and the dish with your name.
8. Make a guess as to the ideal pH for radish seed growth. Record your guess in your data book.

PART B - Days 2-10

1. Remove the lid from the petri dish and remove the paper discs covering the four seeds. Test the pH of the water remaining in the dish. (If it is different from your initial recorded reading, drain the remaining water and replace with the correct level.)
2. Use a ruler or calipers to measure the length of the seeds in millimeters. Average the lengths and record the average in your data book.
3. Sketch the shape of the seeds and note their color.
4. Cover the seeds with the paper discs. Moisten the paper if necessary with the assigned pH solution and replace the lid. (Remember, always test the pH level of the solution before using it.)
5. On the piece of graph paper, set up a graph with age in days on the horizontal axis and length of seeds in millimeters on the vertical axis.
6. Plot the average length of your seeds for the two measurements (Day 1 and Day 2) you have made.
7. Repeat procedures 1-6 each day for the length of the investigation. If the seeds begin to germinate during this time, include the length of any growth in your measurement.
8. Students who are working with the same pH should average their results and have one representative for each pH record the data on the class graph. Use the color assigned to your particular pH.

Discussion Questions:

1. Observe the data on the completed class graph. What appears to be the optimal pH solution for successful radish seed germination?

2. What appears to be the least ideal pH solution for successful radish seed germination?

3. What pH do you think the rainwater has, based on the data gathered? Check your guess by determining its pH with pH paper.

4. Based on the data gathered, what would be the impact of rainwater with increased acidity?

5. Do you think there is reason for concern?

Clearing the Air

Student Activity 9

Concept: Current industrial and individual practices must be modified to avoid further environmental and health problems caused by air pollution.

Objective: Students find articles about air pollution issues and, as a class, use the information to create a chart depicting the causes and effects of air pollution and possible solutions.

Subjects: Environmental science, health, social studies, biology

Skills: Chart interpretation, chart construction, data collection, reading comprehension

Materials:

Copies of Student Worksheet
Large sheet of butcher paper or poster board and writing utensils
Optional: Newspapers, news magazines, and other resources

Introduction:

Air pollution is becoming a serious problem in many parts of the world. For example, 150 million people in the United States breathe air considered unhealthy by the U.S. Environmental Protection Agency (EPA). Every twenty-fourth disability and every seventeenth death in Hungary is caused by air pollution, according to their National Institute of Public Health. And diplomats stationed in Mexico City are awarded hardship pay for breathing the polluted air.[1] While these examples are extreme, cities worldwide are facing increased problems from industrialization's unwelcome side effect, air pollution.

Procedure:

Set-up:

Before class, copy the air pollution diagram from the Student Worksheet onto the butcher paper or poster board. Make sure to leave enough space under each category so that students will be able to fill in the information from their articles. The middle circle can simply be labeled "Air Pollution," rather than trying to list all the article titles. Post this master in an easy-to-reach location so that students will be able to add to it during the class.

Activity:

1. A few days before the activity, have students collect at least two articles or resources about air pollution. Suggest that they make use of the local library and their home supply of newspapers and/or magazines. They may also write a summary of a news show or documentary on television. The following list of topics can serve as a guideline for students in their search:
   - smog in Los Angeles (or other polluted cities)
   - effects of Eastern Europe's rapid industrialization
   - Mexico City's efforts to control its airborne poisons
   - legislation passed to curb air pollution
   - health studies about effects of breathing dirty air
   - damage to outdoor art due to air pollution
   - traffic and industry's role in climate change
   - the connection between air pollution and acid rain (and effects of acid rain).
2. After allowing a couple of days for students to collect their articles and summaries, pass out the Student Worksheets and have students diagram the information from their resources. See chart on the following page for an example of how to use the diagram. You might want to chart a sample article on the master chart so that students understand the concept. Emphasize that students should include as much information as possible on their chart, but that not every category will have something listed. Allow about 15-20 minutes to complete their two charts.
3. As students finish their own charts, they may begin adding to the class version. (You might want to check students' copies for errors before they add to the main chart.) When information is duplicated, students should make tally marks next to the original entry, rather than take up extra space duplicating the information. As some areas become crowded with information, students may need to use arrows to continue the lists. Hang the completed chart in the classroom, and encourage students to add to it if they find further articles or learn more information about air pollution.

Discussion Questions:

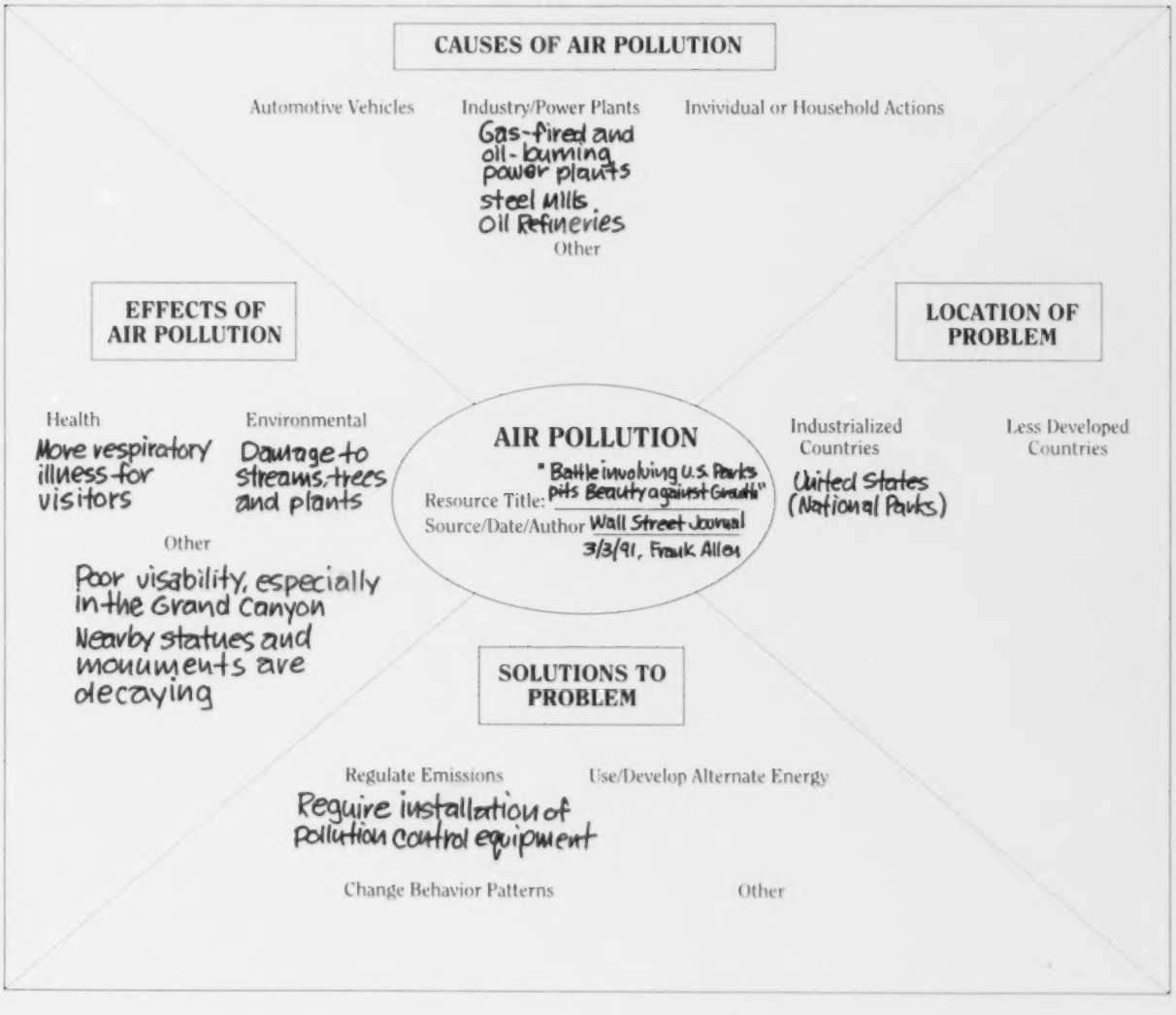
1. Which of the causes on the chart are increased with population growth? Do any of the causes seem unrelated to a growing number of humans?
2. Make a list of important factors for a realistic plan to reduce air pollution. Using these guidelines, which ideas mentioned in the "solution" section seem most feasible? Which seem least feasible?
3. What differences exist between the air pollution problems in heavily industrialized countries and those in less developed countries? Are there also differences in the kinds of solutions they seek? What factors contribute to these differences?

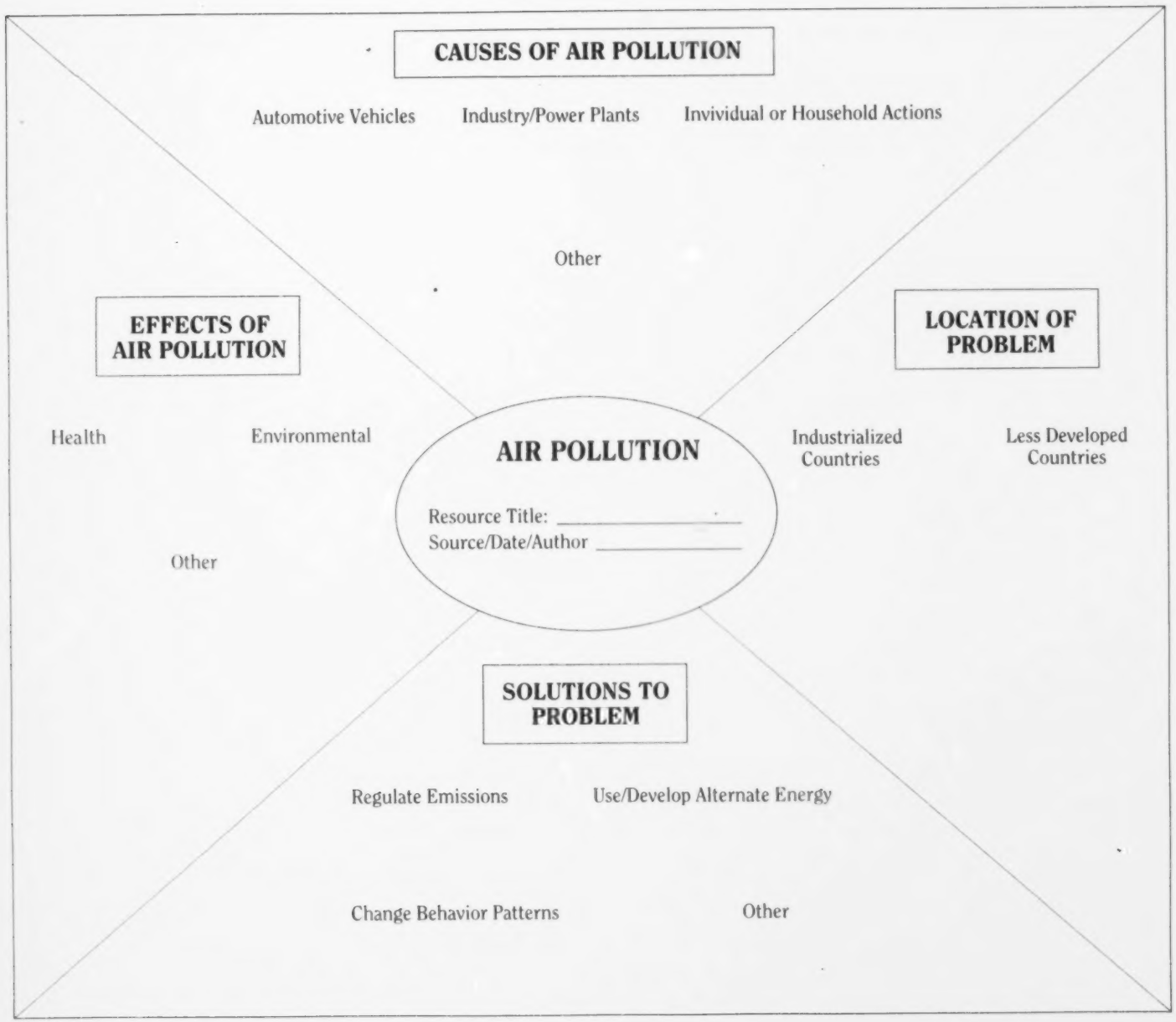
4. Are there any direct links between specific causes of air pollution and certain effects? Which of the causes tend to create more health problems? Which tend to contribute more to environmental damage?
5. What health or environmental risks are most closely associated with acid rain?
6. Considering the air pollution problems in many big cities, why do people continue to gravitate to these heavily polluted urban areas?

Follow-up Activities:

1. Students can research one of the topics listed in the guide at the beginning of this activity and write an investigative report on the subject.
2. Have students chart the population growth rate and airborne poisons increase in cities like Mexico City and Los Angeles, if this information is available.

[1] *Lester Brown, et. al.*, State of the World 1990 *(New York: W. N. Norton and Company, 1990).*




CAUSES OF AIR POLLUTION
Automotive Vehicles
Industry/Power Plants
Invividual or Household Actions
Other
EFFECTS OF AIR POLLUTION
Health
Environmental
Other
LOCATION OF PROBLEM
Industrialized Countries
Less Developed Countries
AIR POLLUTION
Resource Title: _____
Source/Date/Author _____
SOLUTIONS TO PROBLEM
Regulate Emissions
Use/Develop Alternate Energy
Change Behavior Patterns
Other

Water Resources

In Deep Water

Student Reading

Many people take for granted that a clean, plentiful water supply will always be available. Unfortunately, overconsumption and pollution pose dire threats to this critical life support system. As the world's population escalates, so does the demand for water. Population growth over the last 30 years has caused demand for water to double in about half the countries in the world. Residents of rapidly expanding U.S. states like Florida, Arizona and California, as well as citizens of other countries, are dealing with this dilemma on a daily basis.

Through time, we have developed the ability to transport water and employ it in many different ways. However, we have not developed adequate methods of ensuring the best use of this limited resource. A 1990 United Nations Development Programme report revealed that 80 countries, with 40 percent of the world's population, suffer serious water shortages. The World Health Organization estimates that 1.2 billion people still do not have safe water, and efforts to supply it are falling behind population growth rates.

Americans get water from two main sources: the surface water of rivers, lakes, streams and reservoirs, and underground water supplies contained in networks called aquifers. Groundwater provides drinking water for 50 percent of the nation. The increasing demand for groundwater is evident. For example, claims on water from the Colorado River actually add up to more water than flows in the river. Additionally, in 450 of China's 644 cities, water shortages are expected by the turn of the century.

An Unquenchable Thirst

Irrigation and other agricultural practices are responsible for about 80 percent of all water withdrawals on a global scale. The irrigation of land solely for livestock feed accounts for a major portion of the United States water consumption. Because water for irrigation is substantially subsidized by the U.S. federal government, there is little incentive to develop more efficient irrigation systems.

Water has many other uses in addition to irrigation. Industrially, water is used for manufacturing and food processing. Power plants use water to generate electricity. Nuclear power plants and other industries implement water for cooling purposes. Water is used countless times each day by individuals for bathing, drinking, washing clothes and dishes, and flushing toilets, to name a few uses.

As a nation, we withdraw about 400 billion gallons of water each day for residential, industrial and agricultural purposes. This figure translates into approximately 1,600 gallons per person each day. Americans use more water, both in total and in per capita terms, than any other industrialized country in the world. An average resident of Germany or France, for example, uses less than one-third of a typical American's water consumption.

Muddying the Waters

Water shortages are further compounded by pollution. The nature and quality of the world's water have been altered by the impact of various human activities and water uses. The health of two-thirds of the world's population is endangered by the water they drink, cook with and bathe in. This water, polluted and poisoned by sewage, agricultural runoff, and industrial wastes, flows from municipalities, lakes and rivers to our oceans—a total of 20 billion tons of wastes every year.

There are two main areas of water pollution: ocean pollution and groundwater and

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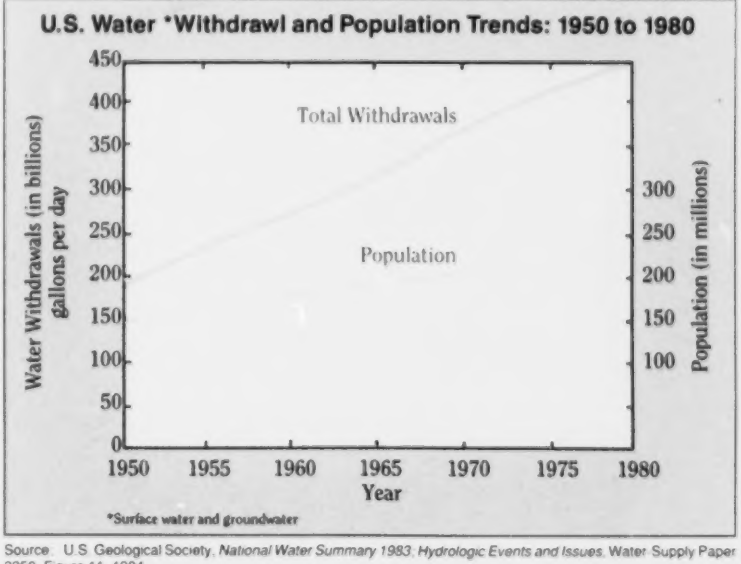
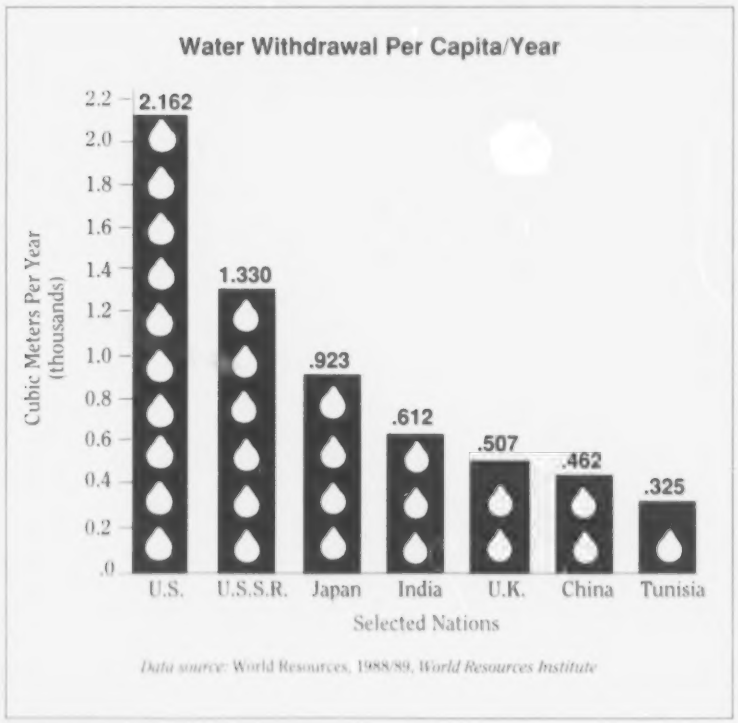


Source: U.S. Geological Society, *National Water Summary 1983: Hydrologic Events and Issues*, Water Supply Paper 2250, Figure 11, 1984.

surface water contamination. The oceans, comprising 71 percent of the Earth's surface area, are recipients of most of the world's wastes. In recent years, unmanaged urban growth, coastal construction, intensive agriculture, offshore oil drilling, mineral extraction, deforestation, boating, overfishing and acid rain have fouled the seas around us. The industrialized countries of the world now put more tons of trash into the ocean each year than they take out in tons of fish. More than 1,300 major industrial facilities in the United States have federal permits to dump their waste directly into coastal waterways. This waste includes hundreds of chemicals, as well as many persistent toxins. The United Nations has tried to control the pollution and overexploitation of the oceans through international conferences and global initiatives, but there is still much to be done in cleaning up global waters.

Another source of ocean pollution is spilled oil. Great attention was brought to this phenomenon when the Exxon Valdez went aground in Alaska's Prince William Sound in 1989, spilling nearly 11 million gallons of crude oil, soiling more than 700 miles of beach, and killing thousands of birds and marine wildlife. During the 1991 Persian Gulf War, Iraq's leader, Saddam Hussein, ordered oil spills as a military tactic. The destruction caused by these spills was estimated to be more than a dozen times greater than the Valdez disaster.



Data source: World Resources, 1988/89, *World Resources Institute*

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A Deadly Drink

Contamination of groundwater and surface water is also a grave concern throughout the world. In developing countries, biological hazards carried through water (in the form of disease-carrying bacteria, viruses, parasites, etc.) are responsible for high infant mortality rates. Parasites, forming from water pollution or poor sanitation practices, are found in surface waters of many semi-arid countries. Microbiological agents and parasites can be contracted from swimming in polluted waters or from consuming contaminated shellfish. This problem is not only found in less developed countries. Popular tourist beaches around the world are experiencing this pollution in varying degrees of intensity.

While water-borne germs dominate the less developed countries, industrial nations have been suffering from chemical pollution. It has emerged as a serious threat to all countries which have introduced industrialization and chemically supported agriculture. The most immediate stress on human health is the consumption of contaminated water. Thus far, 800 different organic and inorganic chemicals have been found in drinking water. Some organic contaminants occur naturally, but inorganic constituents of drinking water are usually the result of various industrial solvents discharged from manufacturing plants, small trade sources, and households.

Pesticide and herbicide residues are carried away by surface runoff, and infiltrate into groundwater as well. This addition of chemicals to aquatic ecosystems causes eutrophication. This process involves the enrichment of waters with plant nutrients, primarily phosphorus and nitrogen, leading to enhanced plant growth. Eutrophication occurs naturally as a slow process over centuries and is in no way detrimental, but the accelerated eutrophication being observed in both fresh and marine environments in most parts of the

world is hazardous. It is predominantly observed in all heavily populated and industrialized countries when pollution containing dissolved nutrients (usually phosphates) are dumped into a body of water. Although substantial global research has been done on this phenomenon, it is still considered one of the most serious water quality problems, and continues to increase in many parts of the world.

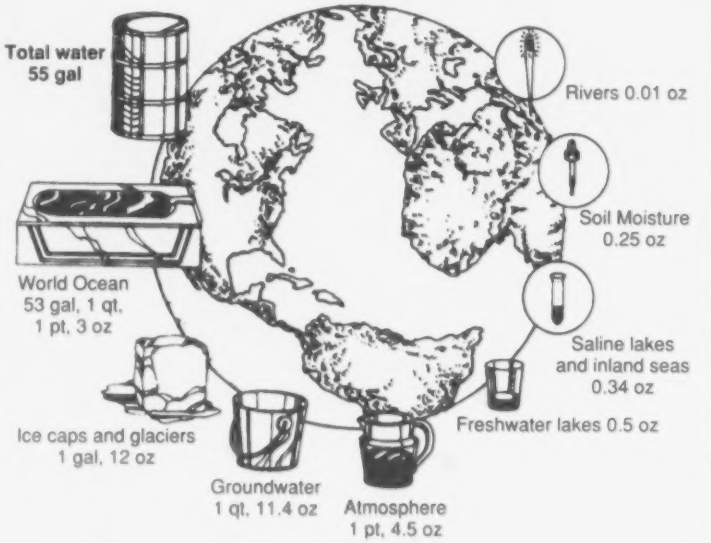
Groundwater is the only source of drinking water for one-half of all Americans. Any pollutant that comes in contact with the ground may contaminate groundwater. For example, a single gallon of used motor oil which comes into contact with a source of fresh water can render one million gallons of that fresh water undrinkable. More than 65 percent of all water pollutants originate in our homes; the sinks and toilets in American households often become the conduits for caustics and household cleaning products. The oil that drips from our cars and the chemicals washed from our lawns can also enter drains and reach groundwater supplies. These practices comprise a huge source of often unmonitored hazardous wastes. As a result, a quarter of usable groundwater in the United States is already contaminated, and in some areas, up to three-quarters is contaminated.

Staying Above Water

In 1972, deciding that something needed to be done on a federal level concerning contamination of waters, Congress passed the Clean Water Act. This was the most comprehensive and expensive environmental legislation in the nation's history. The bill marked a major change in the approach to water pollution control by limiting contaminated discharges and setting water quality standards. Although great strides have been made in cleaning up the nation's waters, significant levels of water pollution still persist.

Very little has been done on the federal level to address water shortages in much of the western United States. While water rationing in some areas has aided conservation efforts, the populations of affected states continue to soar, undermining conservation gains. Similar water crises extend around the globe. Especially in areas experiencing growth and increased urbanization, supplies of clean water are rapidly diminishing.

Every effort should be made to preserve the precious two percent of Earth's waters that we depend on for sustenance. Individuals can aid this effort by using water judiciously and disposing of toxins safely. National governments can encourage cleaner, more plentiful water supplies by strictly regulating industry's and agriculture's water use. Because the vast oceans belong to all the world's people, international cooperation is essential for ensuring water quality for present and future generations.



Though the earth contains vast water resources, only a small part of the water in the hydroshpere is available at any one time for use by people. This figure indicates the world's distribution of water, treating the whole supply as if it were 55 gallons. The primary sources of water for human use are from groundwater, freshwater lakes, and rivers.

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Water, Water Everywhere

Student Activity 10

Concept: Although water covers three-quarters of the Earth, only a small fraction is available for human consumption. As the population grows, water efficiency and conservation become more important.

Objective: Students observe a brief demonstration on the distribution of the world's water and then calculate how much water they use on a daily basis, both directly and indirectly.

Subjects: Biology, environmental science, math, family life

Skills: Estimation, graphing, math calculation, observation, research, writing

Materials:

7 clear containers
(2 one-liter containers; 5 smaller containers, one of which is plastic)
1 plate
Overhead projector
Masking tape
Marking pen
One liter of water
Salt (34 grams)
Sand (approximately 250 ml.)
Blue food coloring
1000 ml. graduated cylinder
One eye dropper
Graph paper
Calculators (optional)
Copies of Student Worksheet
Freezer

Procedure:

Part One:

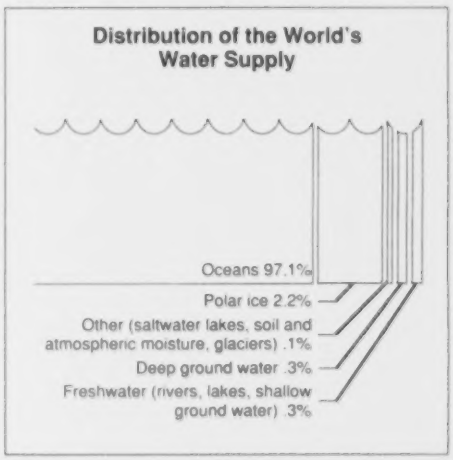
Set-up:

1. Gather all materials.
2. Fill one small container with sand.
3. Fill a one-liter container with water, add four drops of blue food coloring and stir.
4. Label the other five containers as follows: a one-liter container "oceans"; a small plastic container "polar ice"; a small container "deep groundwater"; a small container "fresh water."
5. Make a transparency of the adjacent diagram.
6. Measure and set aside 34 grams of salt.

Activity:

Perform the following class demonstration to help students visualize the distribution of the Earth's water resources:

1. Display the seven containers prepared for this activity.
2. Display a transparency of the figure on the right. Use a graduated cylinder to distribute the one liter of water into the five empty containers according to the percentages indicated in the figure. (For example, 97.1 percent of the water on the Earth is found in the oceans. Because one liter contains 1000 ml., 97.1 percent of one liter is 971 ml. Therefore, pour 971 ml. into the container marked "oceans.")
3. After you have filled the empty containers with the appropriate amounts of water, continue with the demonstration as follows:
   a. Add 34 grams of salt to the "ocean" container, this will match the salinity of the water sample with the salinity of the Earth's oceans (3.5 percent).
   b. Place the plastic "polar ice" container in the freezer.
   c. Set the "other" container aside. We do not have access to this water.
   d. Pour the "deep groundwater" into the container of sand.
   e. Ask the students which of the containers represents fresh water that is readily available for human use. (They should easily see that only the jar marked "freshwater" has the readily available supply.) Initiate a discussion on the limits of fresh water supplies, the problems of population growth and distribution, and the contamination of existing supplies. Only a small part of this fresh water (.003 percent of the Earth's total water supply) is accessible. The rest is too remote (found in Amazon or Siberian rivers) to locate, too expensive to retrieve, or too polluted to use. Hold a plate in front of the class and dramatically drop the usable portion of fresh water onto it. (Represent this portion as one drop of water from an eye dropper.)


Distribution of the World's Water Supply
Oceans 97.1%
Polar ice 2.2%
Other (saltwater lakes, soil and atmospheric moisture, glaciers) .1%
Deep ground water .3%
Freshwater (rivers, lakes, shallow ground water) .3%

Adapted with permission from the National Science Foundation. The original activity appears in the National Science and Technology Week Activity Guide, 1988, *by the National Science Foundation, Washington, DC.*

Part Two:

1. Have students record how many gallons of water they think they use individually in an average day. Later, they will compare this estimated daily water use with their calculated daily water use.
2. As a group, have them list all the ways members of the class use water on a day-to-day basis.
3. Using the data in the table, "Domestic Uses of Water," have them determine their individual water use per day for each activity that the class listed in Step 2. They should include their share of general family uses such as dishwasher and clothes

washer. Then they can determine their individual total water use per day.

4. Students should compare the individual water use calculated in Step 3 with the water use estimated in Step 1. Are their calculated figures higher or lower than their estimated figures? Ask students whether they consider themselves typical water users. Have them explain their answers.

5. Students should now draw a bar graph to illustrate how much water is used by their class for each activity. Which activities require the most water? Using the class average, students should also calculate the average use of their town and/or state.

Suggested Answers to Student Worksheet Questions:

1. Water is needed to grow the food and grasses the calf consumes, in addition to the water it drinks.
2. Student answers will vary.
3. Student answers will vary.
4. Possible answers: purchasing and eating foods which require less water to cultivate (eating lower on the food chain); recycling items to prevent excessive use of water in manufacturing; driving less.
5. Possible answers: take showers instead of baths; don't let water run while brushing teeth or shaving; fix leaky faucets; install water-saving devices for toilet and shower; water lawn less frequently; run dishwasher and washing machine only when you have full loads.
6. Student answers will vary. For further information on water contamination, you may wish to contact the U.S. Environmental Protection Agency, Public Information Center, 401 M Street, SW, Washington, DC 20460; 202/260-2080.

Follow-up Activities:

1. Have students investigate new household products which conserve water (such as low-flush toilets, new shower heads, timed sprinklers, etc.). Each student or group of students could be responsible for writing up a brief synopsis of the costs and benefits of one or two of these products.

   (Note: Free catalogs listing water conservation gadgets are available from: *Eco Source,* P.O. Box 1656, Sebastopol, CA 95473, 800/688-8345; and *Seventh Generation,* 49 Hercules Drive, Colchester, VT 05446, 800/441-2538.)

2. Have students read their home water meters daily for a week, at the same time each day, and report back to the class. They can then compare these readings to their estimates of daily water use. They can then read the meter for a second week, in which they implement many of the conservation measures suggested above.

Adapted with permission from Biological Sciences Curriculum Study. The original activity appears in Biological Science: An Ecological Approach, BSCS Green Version *(Kendall-Hunt Publishing Company, 1987).*

DOMESTIC USES OF WATER

Activity	Gallons Used
Brushing teeth	2–10
Washing hands	2
Shaving	20 (2/min.)
Showering	20–25 (5/min.)
Tub bathing	25–35
Flushing toilet	3.5–8
Getting a drink	0.25
Cooking a meal	5–7
Washing dishes	30 (8–10/meal)
Automatic dishwasher	15
House cleaning	7
Washing machine	24–50
Watering lawn	10/min. (102/1000 m^2)
Leaking faucet	25–50/day

(Faucet and toilet leaks in New York City = 757 million gallons/day)

INDIRECT USES OF WATER

Agricultural

Item	Gallons Used
1 egg	40
1 orange	100
1 ear of corn	76
1 loaf of bread	42
1 kg. flour	165
1 kg. sugar	275
1 kg. rice	1,101
1 kg. beef	5,507

Industrial

Item	Gallons Used
Industrial mining/manufacturing	183/person/day
Cooling water for electric power plants	700/person/day
1 gallon gasoline	26–95
1 kg. steel	77
Sunday newspaper	280
1 kg. synthetic rubber	660
1 kg. aluminum	2,202
1 car	94,825

Water, Water Everywhere

Student Worksheet

1. There are many water uses that are not obvious to most people. Consider, for example, that 1.2 million gallons of water are needed to raise one calf until it is fully grown. Why do you think so much water is needed to raise a calf?

2. Make a list of the ways you use water indirectly, for example, in the production of food you eat or materials you use.

3. Compare your list with the accompanying table, "Indirect Uses of Water." How many of these uses did you list?

4. How could you reduce your indirect use of water?

5. What could you do to reduce your direct use of water?

6. Is there any evidence that the water supply you use daily is decreasing in size or is being contaminated by pollutants? How could you go about obtaining this information?

Roll On Mighty River

Student Activity 11

Concept: Increased demands on U.S. water supply and a diminished amount of unpolluted water cause groups to compete for their "share" of the available supply.

Objective: By investigating water use along the Colorado River, students get a first-hand look at the complexity and frustration surrounding water use problems in our western states.

Subjects: Environmental science, social studies

Skills: Public speaking/debate, library research, decision making

Materials:

Paper and writing utensils for the students
Optional: note cards for arguments and questions
Optional: poster board for charts and evidence

Introduction:

"The Colorado grows grapes in New Mexico, brews beer in Colorado, raises minnows in Utah, floats rafts in Arizona, lights jackpots in Nevada, nurses elk in Wyoming, freezes ice in California, and sweetens cantaloupes in Mexico"[1]. Many of the problems associated with water quality and shortages can be seen clearly and dramatically by investigating water use along the Colorado River. As the following summary shows, there is often not enough water to meet demands and water quality.

Beginning as snowmelt in the Rockies, the Colorado River travels 1,500 miles and drops 12,000 feet before it reaches its destination. The river is greatly altered on its journey; by the time it approaches the dried-up delta on the Gulf of California, it is a salty trickle. This transformation is caused, in part, by irrigation which diverts water into the fields and then re-channels it back to the river, heavy with salt from the soil. For example, as the water leaves the river by the Great Basin in Colorado, its salinity level (salt content) is 200 parts per million; when it returns, it is 6,500 parts per million. In addition, dams create reservoirs and lakes, causing evaporation, which also decreases the amount of available pure water. By the time the Colorado River reaches California, the water is so salty that restaurants serve it with a slice of lemon, and when you pour it on certain plants, they die. Further downriver, in Mexico, the water is virtually unusable for all plants and animals.[2]

Procedure:

1. Break the class into groups of six students. Three students in each group will form a panel of judges assigned to arbitrate conflicting demands on water from the Colorado River. (Some groups may have two or four judges, if numbers are uneven.) The other three students will represent the various groups competing for the water. Have students make nametags to identify their roles. These students are the plaintiffs and their positions are described below:

   A. *Sugar beet farmer in Colorado.* You need water for irrigation to grow your sugar beets. Producing sugar in Colorado is an important farm industry and supports many jobs. Without water for irrigation your farm would be worthless and you would have to move to the city to find work.

   B. *City planner.* You need water for the growing number of people, homes and industries in your city. Without the water, your city will not be able to expand and the local economy will suffer. The city needs clean, unpolluted water for drinking and manufacturing.

   C. *Representative of the Mexican government.* The water that flows out of the United States into the Gulf of California is so polluted with salts that it is virtually unusable. You want the U.S. government to construct a desalinization plant so that water entering Mexico will be pure enough for drinking and irrigation.

2. Give the plaintiffs time to research their positions in the library. This should take one or two class periods. Advise them of the points they should cover, and encourage them to use charts and posters to summarize their positions. The judges will also need to spend time in the library in order to prepare for the trial. They should make a list of questions to ask the different sides during the arbitration, based on their own research.

3. When everyone is ready, hold the trials. To avoid distraction, separate the groups as much as possible, ideally in different rooms. During each trial, the plaintiffs present their cases, using visual aids and note cards when needed, and then answer questions by their panel of judges.

4. After the presentation, the judges need to make a decision and design a plan of action. Each plan should then be presented in front of the class by one of the judges. The plan may include a specific course of action such as giving the city more water and the farmers less. It could require the plaintiffs to conserve water. Or it could recommend technological solutions such as desalinization. The plan should clearly set priorities for water use in the area, justify these priorities, and indicate how conflicting demands might be met in the future.

Follow-up Activities:

As this activity illustrates, short of impractical or extremely expensive methods like weather modification or construction of desalinization plants, it is almost impossible to "create" more water. The only way to make more water available is to conserve it.

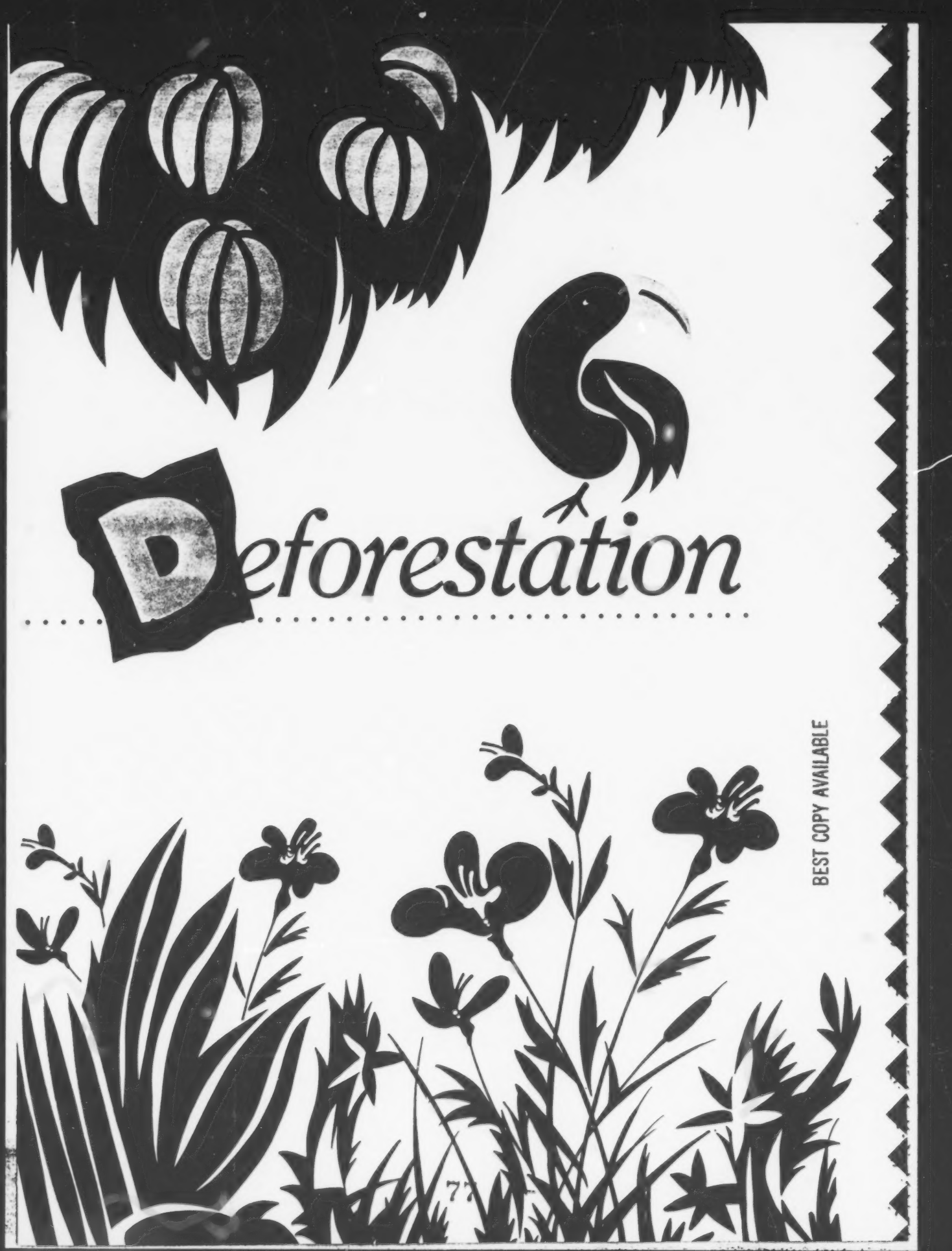
There are many ways to save water in students' everyday lives.

They can take short showers instead of baths, turn the water off when brushing their teeth, wash the car from a bucket rather than letting a hose run, collect rain water to water house plants, and place flow restrictors in showerheads and bricks in toilet tanks to reduce water use. Have students come up with a list of the many possible ways to conserve water. Make a poster listing all the conservation ideas and hang it in the classroom.

One systematic way to save water is to conduct a water audit of the school or individual homes. Have students work through the water audit in "Water – Water Everywhere."

[1] *Jim Carrier, "The Colorado: A River Drained Dry,"* National Geographic *(Washington DC: National Geographic Society, June 1991).*

[2] *Marc Reisner,* Cadillac Desert: The American West and Its Disappearing Water *(New York: Penguin Books, 1986).*



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Deforestation: The Unkindest Cut

Student Reading

The Earth is made up of many different ecosystems, but none more spectacular and life-sustaining than the forests. We depend upon the world's forests to regulate climate, clean air and water, conserve precious soil and provide habitat to much of the planet's wildlife.

Forests of all types are giving way to population pressures, causing irreversible damage to an integral part of our biosphere. Of the approximately 6,750,000 square miles of lush forest canopy that once covered the planet, only 40 percent remains.

Trouble in the Tropics

Of primary global concern is the loss of the Earth's tropical rainforests. Tropical rainforests are defined primarily by two factors: location (in the tropics) and level of rainfall. Rainforests receive four to eight meters of rain each year. The five meters of rain that falls on Borneo each year represents five times the rain that annually falls on New York City. Due to a constant climate, rainforests grow all year long.

The effects of rainforest destruction are felt by every community in the world. Although tropical forests cover less than seven percent of the global land surface, they are home to more than half the species of all living things. Rainforests are a treasure house of foods, medicines, and other resources we have only begun to discover. Less than one percent of rainforest species have even been studied for their potential usefulness.

Tragically, 100 acres of tropical forests are destroyed every minute. The World Resources Institute estimates that the planet loses 51 million acres of rainforest (about the size of Pennsylvania) every year to agriculture, ranching and timbering in Southeast Asia, Africa, and Central and South America. In fact, all the primary rainforests in India, Bangladesh, Sri Lanka and Haiti have been destroyed; the Ivory Coast rainforests have been completely logged out; and the Philippines and Thailand have depleted half of their rainforests since 1960. Of the 8 million square miles of tropical forests that once circled the globe, fewer than 3 million square miles remain, and these are being destroyed at an ever-increasing rate.

A Deep-Rooted Problem

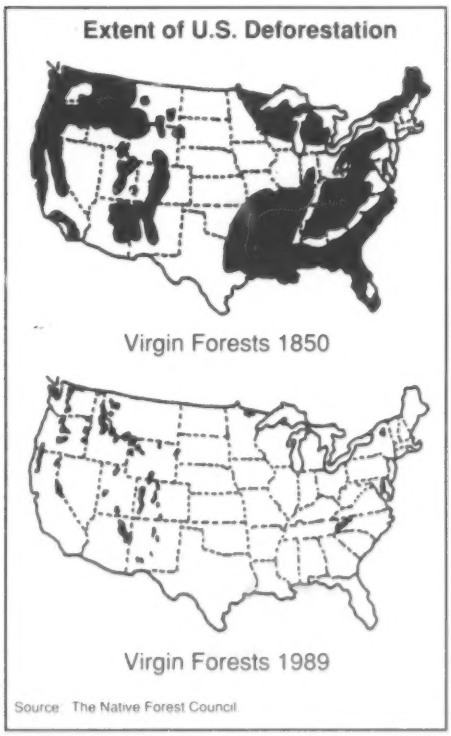
What drives humans to destroy this precious ecosystem? The causes of rapid tropical deforestation are many and often interconnected. The initial and probably most devastating cause has been the lack of knowledge concerning the rainforest. A case study in Brazil illustrates this point. In 1969, Brazil enacted a National Integration Program with the goal of populating Amazonia with thousands of landless and unemployed people. This was in response to overpopulation and inequitable distribution of land and wealth. Another goal of the program was to get wealthy investors to clear the forest lands and raise cattle for export to the industrialized world. The program proved a disaster because the people implementing the project failed to realize that the richness of the once-vast Amazon forest is in its trees, not its soil. Land cleared by slash-and-burn techniques will support a farmer for a year or two before the soil erodes and the farmer is forced to relocate elsewhere to continue this destructive process. With some prior research, such a program would not have been implemented, and vast amounts of Amazonian forests would have been saved. Because of this oversight, the Brazilian government's goals to create additional habitation and grazing land were not realized. This scenario has been repeated in different regions of the world.

Another leading cause of deforestation, particularly in parts of Africa and Asia, is the need for firewood. Nearly one-half of the world's population depends on wood for fuel to cook and to heat their homes. It is estimated that nearly 100 million people are unable to meet their minimum fuel needs. The endless search for wood dominates the lives of millions of women and children who spend anywhere from 100 to 300 days each year looking for firewood.

Timber harvesting is yet another major contributor to tropical deforestation. Tropical forests provide about one-fifth of all the wood used worldwide in industry, and that share is expected to grow as the world's population continues to increase. In the process of harvesting timber, industries build roads to facilitate retrieval of the wood deeper in the rainforest. These roads open once-impenetrable forests to exploitation by miners, hunters, ranchers and farmers.

Deforestation, American–Style

While rainforest destruction is a globally significant issue, the cutting down of old-growth forests in the United States has developed into a national controversy. Since the turn of the century, the U.S. Forest Service has been overseeing the management and protection of national forests. In total, there



are 156 national forests, covering 191 million acres. In September of 1986, the agency released its plans to nearly double the timber harvest from the national forests by the year 2030.

Much of the bitter controversy between environmental groups, the timber industry, and the federal government has been directed toward the fate of the old-growth forests. At one time, old growth covered some 15 million acres in the Pacific Northwest. Some areas included trees ten feet wide, 275 feet tall, and 1,120 years old. But because of their size and bulk, old-growth trees represent valuable lumber to loggers. During the past century, some 12 million acres have been cleared. Less than five percent of the nation's original, virgin forests remain today, compared with Japan's 26 percent. Less than one percent of the nation's native forests are protected from logging. According to the Native Forest Council, U.S. forests are cut at the rate of two football fields every minute.

After the Fall

Both tropical and old-growth forests are rapidly disappearing because they are being logged and burned far faster than they are being replenished. Many of the effects of deforestation are the same for both tropical rainforests and old-growth forests. One of the catastrophic consequences of continued deforestation is mass species extinction, especially in the rainforests, home to more than 80 million species.

Additionally, deforestation causes forests to lose their mediating effects on rainfall, resulting locally in erosion, drought and flooding. Globally, deforestation affects the world's climate. A broad uprising of air follows the rainforest around the equator, driven, in part, by heat absorbed by tropical forests. This massive uprising helps drive the circulation patterns of the entire global atmosphere. Tropical deforestation can disrupt this process, resulting in reduced rainfall and altered weather conditions over a large portion of the globe.

All deforestation adds to the atmospheric pool of rising carbon dioxide emissions, hastening the onset of global warming. An intact forest naturally removes carbon dioxide from the air and stores it through the process of photosynthesis. When trees are cut down, this carbon dioxide is released into the atmosphere.

Pleas for the Trees

Old-growth forests and tropical rainforests play significant roles on Earth. Tropical rainforests, for instance, are the Earth's oldest continuous ecosystems. Fossil records show that the forests of Southeast Asia have existed for 70 to 100 million years. This all stands to be drastically changed if nations continue to sacrifice the Earth's long-term health for short-term profits.

Unless actions are taken soon to end the steady assault on the world's forests, little of this ecosystem will remain for the next generation. Given the pressures of population

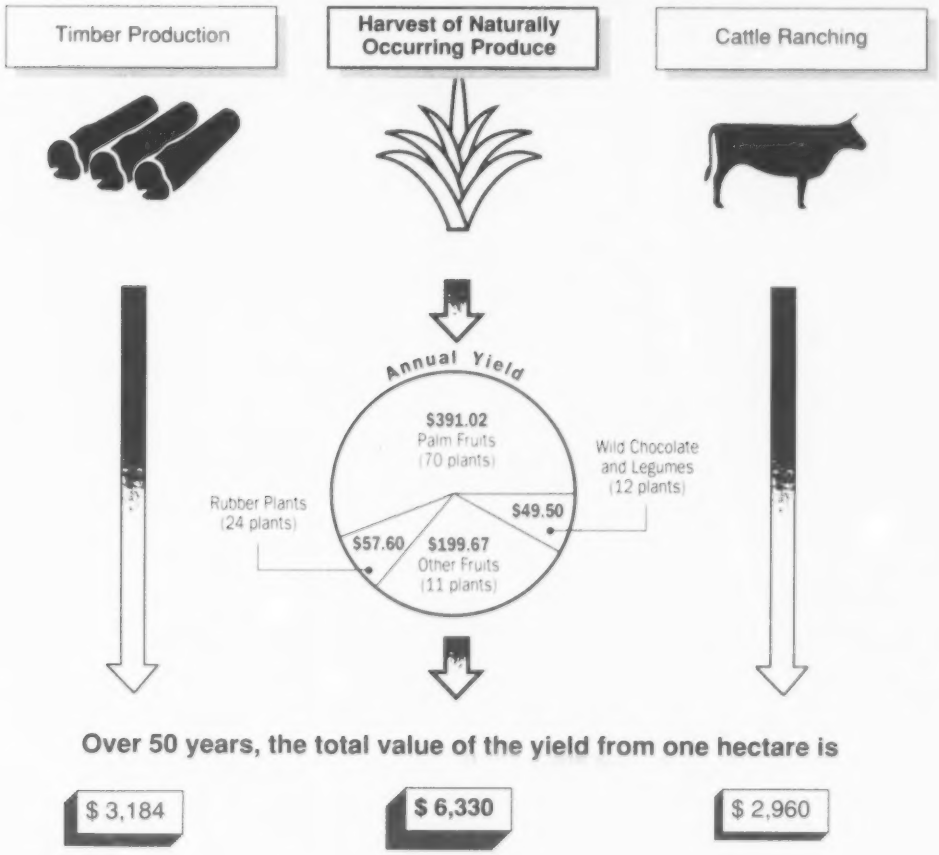
growth, poverty and debt, saving the forests will pose a number of challenges. International cooperation is required to reduce wood demand and implement sustainable forest management. Solutions might include distributing forest land more equitably among indigenous people; harvesting only the forest's naturally occurring produce, such as fruit, chocolate and rubber; and reducing population growth. In the long term, this sort of forest management will reap greater profits than the limited returns of timber production and cattle ranching.

Governments and individuals need to educate themselves about the dangers of forest destruction, or ignorance will lead to further disaster. Above all, we need to realize that every acre destroyed is gone forever.

The Rainforest in Dollars and Cents

A scientific team from the New York Botanical Garden assessed, in U.S. dollars, the profits that could be made over a 50–year period from harvesting and selling the natural products of trees and plants found in an untouched hectare (2.471 acres) in the Amazonian rain forest in Mishana, Peru. Compared to the potential profits from using an equivalent area for cattle ranching or for timber production, the rain forest is twice as valuable if left standing.

One Hectare of Rainforest Can Be Used For



Over 50 years, the total value of the yield from one hectare is

$ 3,184 | **$ 6,330** | $ 2,960

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To Log or Not to Log

Student Activity 12

Concept: Competing interests are vying to control the future of the remaining native old-growth forests, a rapidly diminishing resource in the United States.

Objective: By conducting a mock trial concerning the use of old-growth forests, students research perspectives of various parties in the case and learn about the complexities of trying to save forests for the "greater good."

Subject areas: Social studies, environmental science, language arts, economics

Skills: Research, public speaking, persuasion, evaluation, critical thinking

Materials:

Role-playing cards (duplicated from this activity)

Optional: A judge's gown and gavel

Optional: An instructional guide for mock trials, (see the "Resources" section at the end of this activity). These guides offer hints on setting up a mock trial and provide simplified rules of evidence and court procedure for students to follow.

Introduction:

As the U.S. population increases, so does the demand for lumber. Each year, every person in the United States uses in wood and paper products the equivalent of one 18-inch wide, 100-foot tall tree. The need for more timber has led to a debate concerning the remaining "old-growth" forest. Old growth refers to native forest land which has never been logged. Currently, 80 percent of remaining old-growth forests are slated for logging. This course of action alarms environmentalists who see the old-growth forests as a biologically rich area, valuable to both our country and planet. Of special concern is the logging practice known as clear cutting, when all trees in a region are cut down at once, leading to soil erosion, silted rivers and an altered wildlife habitat. The following scenario illustrates how interests conflict when attempting to regulate land use.

The situation concerning this trial occurs in Pineville, an imaginary small mill town in Northern California. Pineville is surrounded by a vast amount of virgin forest land, most of which is owned by Logs-R-Us, a large logging company. Of the 9,000 Pineville inhabitants, 40 percent have jobs connected to the lumber industry. In addition to the loggers, many town members work in the mill, refining lumber to be shipped to other areas of the state to accommodate the growing housing needs. Another consideration is that the area is known for its excellent hiking and fishing spots. Some of the town merchants depend on out-of-towners stopping for supplies before heading into the wilderness.

Some time ago, Logs-R-Us obtained a cutting permit from the State Department of Forestry, and began felling trees in order to keep up with the growing demand for lumber from other parts of the state. However, Green Rage, a national environmental group, has filed a suit requesting an injunction to cease the logging immediately. According to Green Rage, the land should be designated a natural treasure and allowed to exist in its pristine condition. The group cites a state statute which stipulates that "private land owners shall manage their land responsibly in such a manner as to minimize negative impacts on the greater community and environment."

In an effort to be realistic while still pushing their ideal goal, Green Rage has filed their injunction in such a way that it could be accepted on either of two different levels. Their first claim for relief is to ban all commercial logging. If this claim is denied, their second claim for relief is to ban clear cutting, the most destructive kind of logging. It will be up to the jury to decide which option, if either, seems most reasonable and in accordance with the statute cited. (Note: Such a civil trial would not usually have a jury, but in the interest of involving as many class members as possible, normal legal procedure has been modified for this activity.)

Procedure:

1. To begin, explain that the class will spend the next week participating in a mock trial about a case involving the fate of part of the U.S. native forest. Tell students that they will each participate in the trial and will have to research their roles in order to accurately play their parts. Then read the scenario in the introduction aloud to the students. You may also wish to distribute copies of the scenario and procedure for students to refer to during the activity.

   Assign each class member a role to play during the mock trial and give each a corresponding player's card. The activity is designed for 28 students. However, if you have more, you can add a bailiff, court reporter and members of the media. If you have fewer students, you can either reduce the numbers of lawyers by having one from each side question all witnesses or limit the number of witnesses, keeping the numbers for each side even, if possible. Ask students to read their roles and make a list of what they will need to do to prepare for their role. Encourage students to ask questions about their roles or the scenario.
2. Students should spend the next day or two researching their parts. Encourage students to make use of the library resources, community members and/or relevant organizations. Lawyers need to formulate their opening statements and prepare their witnesses. (Closing statements are flexible since they should also sum up weaknesses in the other side's arguments.)

Witnesses need to research their parts so that during the trial they can speak with authority in their area. For example, the biologist should know the arguments concerning loss of biodiversity and ecosystems related to the destruction of old-growth forests. Members of the jury will not need as much time to prepare and may need to be kept occupied with another assignment; much of their work will be after the trial when they need to deliberate and report back to the court.

(Optional: you may wish to bring a local judge, lawyer, or law student in to speak to the students about legal procedure, or possibly serve as judge during the trial. It is important to get someone who is comfortable around young people and understands that the main goal of the trial is to learn about the old-growth forest debate, not memorize courtroom procedure to the letter. If you do use a guest judge, make sure to provide him or her with a copy of the scenario and role cards before the trial, and have the students contribute to the thank-you note afterward.)

3. The mock trial itself will probably take between two and three class periods. If possible, move the desks and chairs in the room to resemble a real courtroom. For an added touch of authenticity, encourage students to dress for the parts that they will play in the case.

   After the judge is seated, the lawyers for the plaintiff and defendant make their opening statements. In the opening statement, each lawyer explains what he or she intends to prove during the trial and outlines the key facts which will support his or her side. They speak without interruption from the opposing attorneys.

   Next, witnesses are called, first for the plaintiff and then for the defendant. Each witness undergoes direct examination from the attorney on the side he or she is representing and then cross examination by the other side's attorney. During direct examination, the lawyers are not allowed to ask questions which suggest the answer (e.g. you can't ask the president of the logging company, "Isn't it true that your company places environmental concerns as a primary goal in planning for the future?"). However, during cross examination, questions of this kind are acceptable.

   After all witnesses have been heard, lawyers from both sides make their closing statements.This is when the lawyers really argue the case to the jury. They make a summation of all evidence and give a persuasive pitch for a decision in their favor. Finally, the jury deliberates and reports back to the class (or, for educational purposes, you could have the jury meet in front of the class so other students can see how the decision is made and which evidence is most persuasive). In civil cases, 9 out of the 12 jurors need to agree to have the verdict be binding.

Follow-up Activities:

1. After the trial, have students write reports about whether they agree or disagree with the decision of the jury, including what they would have done differently if they were attorneys for the plaintiff or defendant. Discuss ways the case might have been settled and negotiated out of court. Also, students could plan a field trip to the local court and see a real trial in action.
2. Students should look into land use in their area. Find out if there are any conflicts of interests between local parties. Does one party seem to be more concerned about short-term profits while another is concerned about the long-term consequences? How would students feel if one of the main sources of income in their community was shut down? The entire trial could be re-worked, using a different land-use scenario appropriate to the local situation, as a supplement to or adaptation of this activity.

MOCK TRIAL RESOURCES:

Putting on Mock Trials, compiled by the American Bar Association is available for $1.00 from the Special Committee of Youth Education for Citizenship, 750 North Lake Shore Drive, Chicago, IL 60611; 312/988-5555.

Street Law Mock Trial Manual, by the National Institute for Citizen Education in the Law. Available for $10.95 through the Social Studies School Services Catalog, 10200 Jefferson Boulevard, P.O. Box 802, Culver City, CA 90232-0802; 800/421-4246.

ROLES

ATTORNEYS FOR THE PLAINTIFF:

Green Rage hired members of the Environmental Legal Defense Group to represent them in this trial. The following lawyers are a part of the team:

Plaintiff Attorney #1: Opening Statement

At the beginning of the trial you inform the jury of the nature and facts of the case, without interruption from the defense. You summarize key facts each witness will bring out in testimony. Finally, you explain what you are asking the jury to decide (i.e., to stop all commercial logging of this old-growth forest).

Plaintiff Attorney #2: Direct Examination

You question all witnesses in favor of banning the logging. Your purpose is to present the evidence necessary to convince the jury to decide in favor of Green Rage. You want to present your witnesses in the best possible light and establish their credibility.

Plaintiff Attorney #3: Cross Examination

You question witnesses called by the defense (i.e., those in favor of logging). Your purpose is to obtain admissions from the witnesses which tend to prove your case and to discredit these witnesses. (Hint: "Yes or no" questions tend to be more effective than questions which ask the witnesses to explain in their own words.)

Plaintiff Attorney #4: Closing Statement

You summarize the highlights of the testimony as it supports your case and undermines Logs-R-Us' case, using actual examples from the trial that you have written down. Persuasively request that the jury decide in favor of Green Rage to stop the logging.

WITNESSES FOR THE PLAINTIFF:

Biologist

As an expert in the field of biology, you need to educate the court about the importance of old-growth forests in the biosphere. You should emphasize the loss of biological diversity when an entire ecosystem is destroyed.

Chairperson of Outdoor Enthusiasts Club

As one who appreciates the exceptional beauty of this wilderness area, your testimony should illustrate an alternate use of the forest which will inflict far less damage than clear-cutting the land.

Environmentalist for Green Rage

You believe that people need to look beyond short-term gains and protect the environment for the good of future generations. Try to emphasize the "big picture" loss if old-growth forests are destroyed.

Native American

Your ancestors have lived in harmony with the land for many years before the white man came and began destroying the forests. Your testimony should illustrate that land ownership should not necessarily involve the right to damage something that belongs to everyone.

ATTORNEYS FOR THE DEFENSE:

Logs-R-Us hired a prestigious legal firm, Powers and Dinero, from San Francisco to try the case. The following lawyers are a part of the team:

Defense Attorney #1: Opening Statement

You speak at the beginning of the trial after the plaintiff's opening statement. Your purpose is to deny that Green Rage has a valid claim and, in a general way, outline the facts from the standpoint of Logs-R-Us. You will not be interrupted by the plaintiff during this speech.

Defense Attorney #2: Direct Examination

You question all witnesses in favor of continued logging. Your purpose is to present the evidence necessary to convince the jury to decide in favor of Logs-R-Us. You want to present the witnesses in the best possible light and establish their credibility.

Defense Attorney #3: Cross Examination

You question the witnesses called by the plaintiff (i.e., those opposed to logging). Your purpose is to secure admissions from these witnesses which will be favorable to your case and discredit the witnesses. (Hint: "Yes or no" questions tend to be more effective than questions which ask the witnesses to explain in their own words.)

Defense Attorney #4: Closing Statement

You summarize the highlights of testimony as it supports your case and undermines Green Rage's case, using actual examples from the trial that you have written down. Persuasively request that the jury decide in favor of Logs-R-Us and allow the logging to continue.

WITNESSES FOR THE DEFENSE:

Developer

You need to fulfill a contract to build new houses in the Los Angeles area and you were counting on this lumber from Logs-R-Us. You should speak of the growing demands for housing and other wood products in the state.

President of Logs-R-Us

You need to convince the jury that your use of the land *is* acting for the greater good of the community and the environment. You might want to talk about services your company provides to the community and efforts the company makes to replant logged forest areas.

Pineville Chamber of Commerce Representative

Since a large percentage of Pineville's citizens depend on the logging industry, you are concerned for the future of the town's economy if its major source of revenue is removed. You should speak of the numbers of jobs lost, and the probable fate of those who are untrained in other professions.

Pineville Mill Worker

If Logs-R-Us is prevented from logging, your mill will undoubtedly close and you will be out of a job. You have a family of five to feed and don't want to go on welfare. Also, since Pineville will be economically depressed, you will probably have to move your family to another town, leaving your neighborhood and friends.

MEMBERS OF THE JURY

MEMBERS OF THE JURY (twelve students)

You need to listen carefully to all points of view represented in the trial since it is your job to determine the facts in the case. After everyone has finished, it will be up to you and the 11 others to decide in favor of either Green Rage or Logs-R-Us and tell your decision to the court. In order to reach a valid verdict, at least nine of you must agree on the final recommendation to the court. (Hint: Your decision will be influenced by how you interpret the state statute cited in the case, which reads, "Private land owners shall manage their land responsibly in such a manner as to minimize negative impacts on the greater community and environment.")

Go for the Green

Student Activity 13

Concept: The Earth's rainforests are irreplaceable ecosystems that hold a significant place in the global environment. However, economic interests often pose obstacles to rainforest preservation.

Objective: Through playing the board game, "Go for the Green," students gain an appreciation of the complexities of preserving rainforests through decision making scenarios.

Subject Areas: Social studies, environmental science, biology, economics

Skills: Decision making, game strategy

Materials:

Choice and Risk cards and game board (duplicated from this activity)
Dice
Game pieces (be creative)

Introduction:

Tropical rainforest destruction is an alarming issue, commanding the attention of scientists, environmentalists and politicians worldwide. There are no easy solutions because deforestation is occurring for many reasons. Governments, banking institutions, indigenous people, loggers, and other groups differ on how the rainforests should be used. The pursuit of "green" currency may place the "green" ecosystem in jeopardy. The following game illustrates the difficulty of maintaining an ecological and economic balance when addressing rainforest issues.

Preparation:

The game is best played in groups of three to five students. You will need to reproduce the game board as well as the Choice and Risk cards so that each group has all three. (Note: Copying the Choice and Risk cards on different colors of paper avoids confusion.) Each stack of cards should then be placed face down on the game board. You also need to decide what you will use as game pieces. This could range from pen caps to something you may have in your room that is related to the subject (i.e., rubber bands, sticks of gum, nuts, etc.)

Rules of the Game:

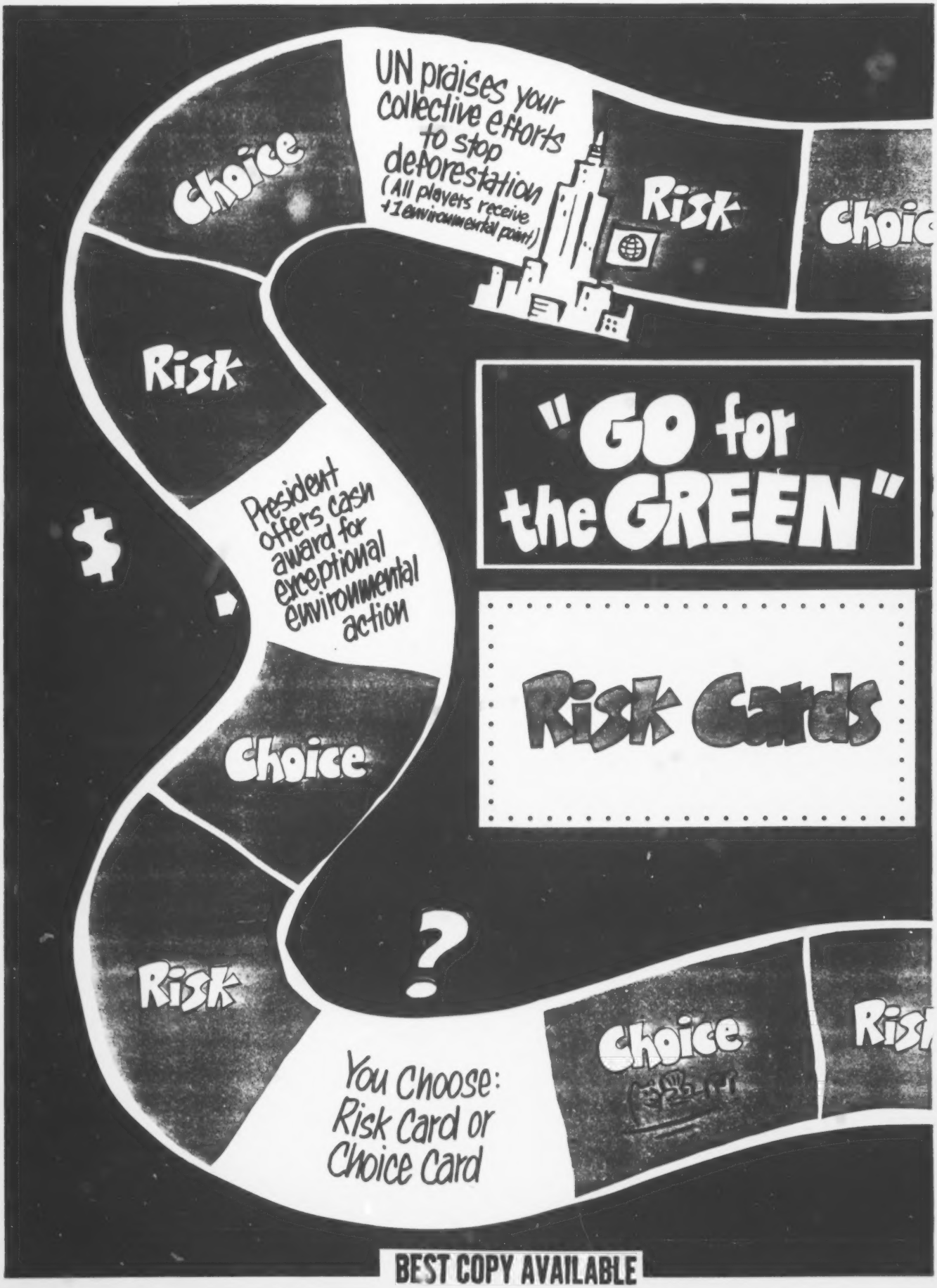
1. Each player will be responsible for keeping track of his/her points through each round. Before the game begins, have each student make a chart on a piece of paper with two headings: "Environmental Points" and "Wealth Points."
2. Each player will start with 4 environmental points and 400 wealth points. *The winner of the game is the first player to get 10 environmental points* ***and*** *1,000 wealth points.*
3. The players may place their markers anywhere on the game board to start. Movement around the board is in the clockwise direction. They can roll the dice to determine the order of the turn.
4. Each player will roll the die and move around the board for the designated spaces. After landing on a space, follow the directions given on the board.
5. If required to pick a Choice or Risk card, students pick from the top of the pile and put the card at the bottom of the pile when they are through.
6. A player may not choose an option on a Risk or Choice card which would put him or her into debt. For example, if a player has 300 wealth points and he or she picks a Choice card that has an option to lose 400 wealth points, this option cannot be chosen because the player does not have enough wealth points. But if a card *requires* a player to pay 300 wealth points and the player only has 200 wealth points, that player will be in debt for 100 wealth points. In other words, a player cannot voluntarily go into debt.

Note to the Teacher:

If you find there is no winner by the end of the allotted time, reward each player 100 wealth points for each environmental point and total each player's wealth points. The player with the highest number of wealth points will be the winner. It is advisable not to tell the students of this rule ahead of time because it may change their strategy when playing.

Follow-up Activities:

1. Lead a discussion on the outcome of each group's game and what students learned from their choices.
2. Have students research one of the specific areas discussed on the Choice or Risk cards (for example, the effects of rainforest destruction on the indigenous peoples).
3. Have the class choose a specific rainforest of interest and conduct an in-depth study of all the aspects of the controversy. Break the students into groups and assign specific subtopics for research.



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Choice Cards

Risk

Heavy rains and soil erosion cause a destructive mud slide
(-75 Wealth Points)

Choice

Time Magazine prints your article on rainforest destruction
(+1 environmental point)

Risk

Choice

International Holiday - No activity
(Miss A Turn)

Risk

Choice

Record Nut Harvest
(+100 Wealth points)

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"GO FOR THE GREEN" GAME CARDS

CHOICE CARD

You are the Minister of Agriculture for Thailand. Your job is on the line due to the lack of progress your country has made in dealing with the problem of feeding an increasing population. You can:

Decide to tear down rainforest land as a desperate measure to plant more crops for food (– 1 environmental point, + 250 wealth points) **or:**

Make a controversial political move and propose seeking assistance from industrial countries, thereby going deeper into debt (+ 100 wealth points) **or:**

Make a stand for the environment and resign from the job, stating your opposition to destroying more rainforest and emphasizing the need for a comprehensive population policy (+ 3 environmental points, – 200 wealth points).

CHOICE CARD

You are aware of the increased energy needs created by a rapidly growing population. As a graduate of a prominent Brazilian engineering school, you have two job offers in the energy field. You can:

Work with a low-paying, nonprofit group, designing and building an experimental solar energy system resting in the rainforest canopy (+ 2 environmental points) **or:**

Work on the operation and maintenance of a hydroelectric dam which generates large amounts of electricity, but also damages the surrounding rainforest (–1 environmental point, + 350 wealth points).

CHOICE CARD

You run a small-scale mining operation in the Amazon region, bulldozing and dredging stream banks in search of gold ore. The government has recently enacted new environmental regulations on mining practices in your region. In order to comply with these regulations your company would have to forfeit almost one year's profit. You can:

Follow the regulations to the letter and write your money off (+ 2 environmental points,– 250 wealth points) **or:**

Use a favor owed to you from local officials to postpone an inspection of your operation, giving you a year's leeway (+1 environmental point, – 100 wealth points) **or:**

Go deeper into the forest and set up a secret mining operation illegally, disregarding all environmental and health regulations (– 2 environmental points, + 250 wealth points).

CHOICE CARD

Giggley's Gum, Inc. has doubled its order for chicle latex (used to make chewing gum) next year. However, your land is currently producing as much chicle latex as possible and you are unable to fill the order. You can:

Tell Giggley's you are unable to provide that amount of product (+ 1 environmental point) **or:**

Slash and burn surrounding rainforest to cultivate new plants and promise Giggley's you will fill the order within a year or two (– 1 environmental point, + 200 wealth points).

CHOICE CARD

Due to an increased number of espresso drinkers worldwide, demand for the coffee beans from your land has risen dramatically. You can:

Meet the demand by over-planting and cutting down surrounding land. Although this process will destroy the land within five years, you will have made enough money to retire (– 2 environmental points, + 300 wealth points) **or:**

Maintain production schedule, hoping that the demand will continue indefinitely, and allowing the land to survive for other uses (+ 2 environmental points, – 150 wealth points).

CHOICE CARD

You go to the grocery store for your weekly items. You see that many of the store-brand products are cheaper, but you usually shop environmentally by paying attention to packaging and looking for products harvested from tropical rainforests. You can:

Purchase the store brand items to save some money (– 1 environmental point, + 50 wealth points) **or:**

Spend the extra money on the sustainable products and support the rainforest region (+ 1 environmental point, – 50 wealth points).

CHOICE CARD

You live in the United States and raise exotic birds. Much of the rainforest habitat of your favorite species has been destroyed, due to irresponsible practices and increased demands on the forest caused by human overpopulation. The bird is in danger of becoming extinct. You can:

Stop importing the birds from where they have been captured and removed from their natural habitat (+1 environmental point) **or:**

Create a private bird sanctuary and continue importing and breeding these birds, figuring you can provide a safer environment than the decreasing forest (+ 2 environmental points, – 150 wealth points) **or:**

Capitalize on their increasing rarity by importing and breeding the birds to sell for profit in the United States (– 1 environmental point, + 200 wealth points).

CHOICE CARD

You own a small cashew plantation. The large American company, Nifty Nuts, Inc., has decided not to renew your contract for cashew shipments. You can:

Hold on to your land, forgo the money from this year's harvest, and hope for better luck next year (+ 1 environmental point, –150 wealth points) **or:**

Join forces with several other small farmers, combining land so that you can share profits and losses (+ 50 wealth points) **or:**

Sell the land to a big cattle rancher who needs more grazing room (– 1 environmental point, + 150 wealth points).

CHOICE CARD

You are a manufacturer of rubber wetsuits in Los Angeles. You have two options for sources of the raw rubber. You can:

Buy from small farmers, who extract the rubber sustainably, at a higher price (+ 1 environmental point, – 100 wealth points) **or:**

Buy from large plantations who have cleared forest for their rubber crops (– 1 environmental point, + 150 wealth points).

CHOICE CARD

The government of Zaire has offered you a contract to build a road into one of the rainforests to facilitate commercial game hunting. You can:

Refuse the job, explaining that large-scale commercial hunting leads to extinction and that the road construction will completely disturb the ecosystem (+ 2 environmental points, – 300 wealth points) **or:**

Accept the job, reasoning that someone else would do it if you didn't, and people need to eat (– 2 environmental points, + 300 wealth points).

CHOICE CARD

A new plant species has been discovered on land you own in the rainforest. Scientists believe the plant may have healing powers. You can:

Sell the land to the government which intends to research this plant, although you cannot be assured this government will stay in power long enough to conduct the necessary research (+ 150 wealth points) **or:**

Keep the land in its natural state and receive a small stipend from an international science group conducting their own research (+ 1 environmental point, + 50 wealth points) **or:**

Continue to slash and burn the land for profit (– 2 environmental points, + 300 wealth points).

CHOICE CARD

As a National Geographic photographer assigned to capture the beauty of Indonesia's rainforest, you are determined to travel deep into the heart of the forest. When making travel plans you can:

Take a plane operated by a large-scale developing company, lasting about an hour (– 1 environmental point, + 1 extra turn) **or:**

Hire a guide, buy provisions, and travel the distance by river and on foot, taking two extra weeks (+1 environmental point, – 75 wealth points).

CHOICE CARD

You are a leader of a group of migrant peasants in the Ivory Coast. Due to population pressures and overuse of rainforest land, your people are forced to travel from area to area within the forest for fuel, food and shelter. Now environmental and government groups are pressuring you to give up your lifestyle so the land can be preserved. You can:

Accept their arguments that your practices are harming the rainforest and move your people to an area where you do not know how to survive (+ 2 environmental points, – 300 wealth points) **or:**

Continue to live off the land as long as you possibly can and petition to continue your way of life (– 1 environmental point, + 150 wealth points).

CHOICE CARD

You are the president of Sunny Drinks, Inc. Your company's product, Truly Fruity, is not selling because it doesn't have enough tropical fruit flavor. You can:

Use "incentives" to encourage your tropical fruit supplier to triple the output of their crops without having to purchase extra land (– 2 environmental points, + 250 wealth points) **or:**

Spend the extra money on fruit which is sustainably harvested and base a new ad campaign on the need to preserve rainforests (+ 1 environmental point) **or:**

Cut your losses and abandon the line altogether, concentrating on your popular Prunetta Punch (+ 50 wealth points).

CHOICE CARD

You are a young entrepreneur and have successfully opened a small furniture shop. A salesman comes into your shop with beautifully made mahogany desks, asking an unbelievably low price. You can:

Refuse to purchase the items because mahogany comes from the rainforest and you boycott such products (+ 1 environmental point, – 100 wealth points) **or:**

Purchase many of the desks to sell in your store (– 1 environmental point, + 200 wealth points).

CHOICE CARD

You are a cocoa supplier for Sweet Dreams, Inc., which is coming out with a new product called Choco-Caramel Delight. The company has strong indicators that this will be a smash so they want to increase production. You can:

Increase land for planting cocoa by destroying an area of rainforest you had set aside for public relations reasons (– 2 environmental point, + 250 wealth points) **or:**

Continue to produce the same amount of cocoa and send Sweet Dreams elsewhere for their additional need (+ 1 environmental point).

CHOICE CARD

You have handled guns your whole life. One day at the shooting range, you are approached by two businessmen who proposition you to go to Central Africa and commercial game hunt. You can:

Decide to go because the money is good and you love hunting. However, the numbers they are asking you to kill could have a detrimental effect on the survival of several species (– 2 environmental points, + 300 wealth points) **or:**

Strike a bargain with the businessmen and agree to kill a certain quota of game that will allow the species to continue to survive (+ 1 environmental point, + 50 wealth points) **or:**

Decide to decline the offer in hopes of avoiding the possible wholesale slaughter of several game species (+ 3 environmental points, – 300 wealth points).

CHOICE CARD

You have won the state lottery and decide to go on your dream vacation to the Malaysian rainforests. When making your travel arrangements you have two options. You can:

Take advantage of a "budget deal" offered by your local travel agency, which charters an American plane and uses American guides (– 1 environmental point, + 150 wealth points) **or:**

Pay more for an "eco-tour" which emphasizes learning about the environment and ensures that money goes to the local economy, lessening economic pressures on natives to cut down the forest (+ 1 environmental point, – 150 wealth points).

CHOICE CARD

A world-famous Indian chef has identified the missing ingredient in one of her new specialties. All she needs is a spice that is found in a plant indigenous to the Brazilian rainforest. This plant is on your rainforest land, but has been preserved because a specific species of lemur feeds only on this plant. You can:

Let your stomach do the talking and extract the spice from the plant at the expense of the lemur (– 2 environmental points, + 300 wealth points) **or:**

Send the chef elsewhere, which will certainly please the lemur (+ 2 environmental points) **or:**

Allow the chef to extract the spice from a portion of your land, thereby preserving the lemur's supply (+ 1 environmental point, + 100 wealth points).

CHOICE CARD

You have received a large sum of money from a film distributor for a documentary you made about the plight of the tropical rainforests. You can:

Give the money back to the countries where you shot the film, by setting up conservation and service groups (+ 3 environmental points, – 200 wealth points) **or:**

Keep the money and buy yourself some well-deserved treats (+ 200 wealth points).

RISK CARD

You are a subsistence farmer struggling to make a living off your plot of rainforest. A large cattle rancher is urging you to sell your land so he can tear down your plot for grazing. If you have 500 wealth points, you are able to resist (+ 1 environmental point). However if you have less than 500 wealth points, you are forced to sell out (–1 environmental point).

RISK CARD

Due to improper maintenance, a fuel storage tank for logging equipment leaks toxic substances into the water supply. You lose 2 environmental points unless you have 500 wealth points to take care of the problem before significant damage is done. If you have 500 wealth points or over, your score remains the same.

RISK CARD

A huge forest fire is raging throughout Indonesia's East Kalimanton. If you have virgin/unlogged forest (5 environmental points or more), you are okay. If you have logged forest, you lose it all (– 300 wealth points).

RISK CARD

A U.S. zoo would like to find a mate for their female macaw. They want to breed the species because it is considered endangered. If you have enough unlogged forest (5 environmental points or more), you can take advantage of the zoo's offer to pay 400 wealth points for a male macaw.

RISK CARD

A heavy rainfall floods your land and causes tremendous erosion because you were forced to live on marginal ground due to overpopulation. You lose 150 wealth points.

RISK CARD

An International Global Warming Coalition is offering financial assistance to those who have demonstrated dedication to preserving the rainforests. If you have 5 or more environmental points, you get 200 wealth points.

RISK CARD

An elderly eccentric landowner is offering to sell a large tract off rainforest to someone willing to commit to preserving the land. You may trade 150 wealth points for 2 environmental points, if you want to do this.

RISK CARD

Large amounts of curare are found on your segment of the rainforest. (Curare is used as a muscle relaxant for surgery.) A hospital chain from Europe gives you 150 wealth points for your supply.

RISK CARD

A wealthy European perfume manufacturer is interested in extracting oils from some rainforest plants (bay oil, camphor oil, eucalyptus oil, patchouli oil, rosewood oil, sandalwood oil, and ylang-ylang). If you have 5 or more environmental points, you receive 100 wealth points from this company.

RISK CARD

You are throwing a large party and want to serve some ecologically sound food; however, you have financial concerns to consider. If you have 400 or more wealth points, have a "rainforest caterer" deliver nuts, dried fruits, palm hearts, etc. (+ 1 environmental point) or: if you have under 400 wealth points, forgo the environmental snacks and buy pretzels.

RISK CARD

You and your family are attacked by guerrillas fighting civil war in Mozambique. Unfortunately, your son is severely hurt. If you have 400 wealth points, he can get the necessary medical attention. However, if you do not and he should die, your number of laborers will be too low and you will be forced to sell your rainforest land to the loggers (– 2 environmental points).

RISK CARD

Your deforestation practices in the Himalayan mountains helped contribute to the 12 million acres of damaged land in India (–1 environmental point).

RISK CARD

As a wealthy alumnus of an Ivy League university, you are approached by a group of students trying to start a conservation biology program. If you want to support their efforts, you may trade 150 wealth points for 2 environmental points.

RISK CARD

Your new line of rainforest cosmetics is a big hit. Not only is it selling well (+ 100 wealth points), but it is raising awareness of rainforest destruction and promoting sustainable harvesting (+ 1 environmental point).

RISK CARD

This is your lucky day! On your way to an important conference on saving the rainforest, you are seated next to Madonna on the plane. You convince her not only to attend the conference, but to promote your cause on her next album (+ 2 environmental points).

RISK CARD

You have clear-cut the rainforest to provide pastures for your cattle. However, within a year, the land is invaded by toxic weeds which kill all your cattle (–1 environmental point, –100 wealth points).

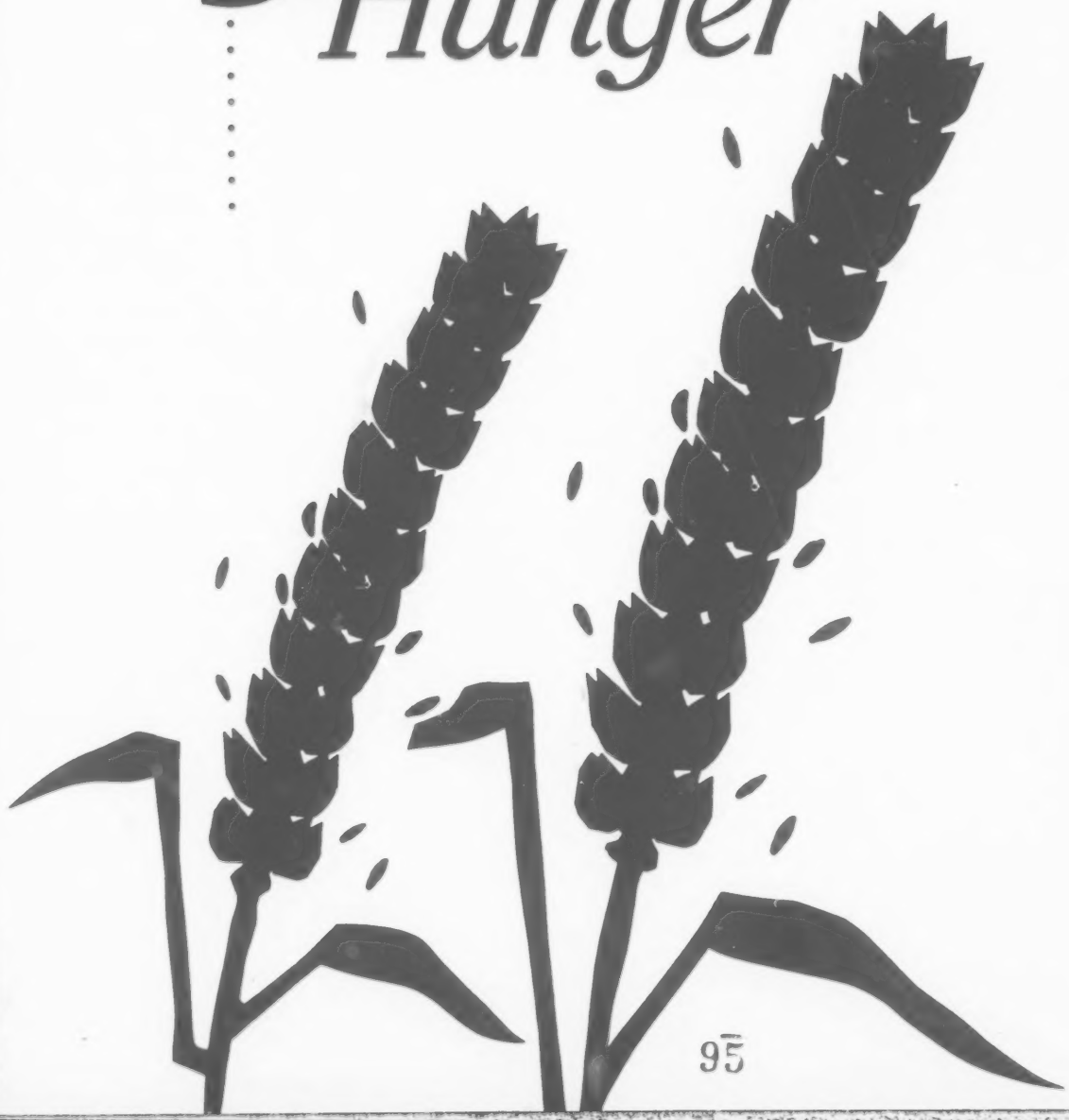
RISK CARD

Congratulations! Your proposed "debt-for-nature" trade between a U.S. bank and the government of Zaire was adopted (+ 1 environmental point).

RISK CARD

You have developed a series of rainforest preservation T-shirts which have become a huge success with teenagers (+ 1 environmental point, + 100 wealth points).

Food and Hunger



Feeding the Global Family

Anyone who has ever driven through the endless amber waves of grain in America's Midwest may find it difficult to believe that we are in the midst of a global food crisis. But more than one billion people, 20 million within U.S. boundaries, do not have enough food to sustain a normal, active life. For those countries where the problems are most severe—primarily in regions of Asia, Latin America and Africa—hunger is a daily concern, with serious social, political and economic consequences.

Is world hunger primarily a result of inequitable food distribution? According to Brown University's "Hunger Report," if we could take all of the world's vegetative foods and the products of range-fed animals and distribute them equally among all the world's people, there is enough food to feed six billion people, the projected population for 1998. Less than three billion people, just over half of 1991's population of 5.4 billion, could be fed on an American-style, high-protein diet which includes a variety of animal products.

People Outpacing Food

Agricultural technologies developed during the Green Revolution of 1950-1975 gave hope that food production could continue to keep pace with the world's growing population. High-yield crop varieties, chemical fertilizers and pesticides all contributed to increased food production. Today, as the population grows by 95 million each year, world food output is being slowed by environmental degradation and a scarcity of new cropland.

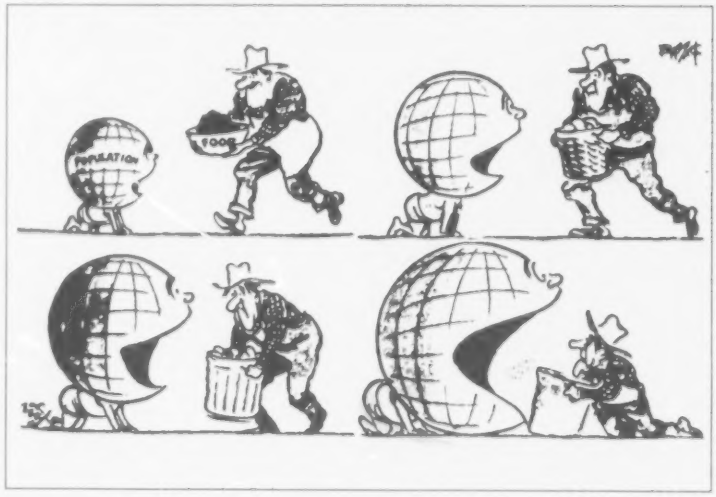
The combination of worldwide poverty and population growth is forcing the overgrazing of rangelands and the over-cultivation of croplands, both of which are at the root of unsustainable farming. To provide for other basic needs of growing populations, much arable land is converted for non-agricultural uses such as homes, roads and other development.

Blowing in the Wind

Soil erosion is the primary threat to the world's cropland. Each year, farmers lose an estimated 24 billion tons of topsoil from their cropland in excess of new soil formation. This erosion occurs when the rich organic matter and nutrients in the topsoil are washed or blown away due to poor agricultural practices and droughts. It takes from 200 to 1,000 years for just one inch of topsoil to form. According to the United Nations, some 23,000 square miles of land worldwide—about the size of West Virginia—become irreversibly desertified every year. Deforestation, overgrazing and excessive irrigation practices are the major contributors to topsoil erosion.

Student Reading

Deforestation affects food production in several ways. When trees are removed, topsoil runs off, leaving the land unproductive. Increased runoff and crop-destroying floods have been particularly devastating in India and Bangladesh. Continuing deforestation in developing countries forces villagers to find fuel other than firewood. Dried cow dung and crop residues are the most common fuel alternatives in rural areas. But burning this organic matter deprives the croplands of needed nutrients. Deforestation also depletes the "genetic library" service of the rainforests, habitat for countless species of plants and animals. Genetic engineers have relied on new-found species in the rainforests for improving upon existing crops.



GENE BASSET reprinted by permission of NEA, Inc.

Increased irrigation, which has allowed for greater crop production in past years, is also responsible for cropland damage. About one-third of the world's irrigated cropland is losing productivity as a result of waterlogging and salt accumulations. Whereas rainwater is essentially distilled, irrigation water contains salts which are left in the topsoil upon evaporation.

Overgrazing, too, has wreaked havoc on the world's grasslands. In much of the world, livestock populations have increased with human population growth. In Africa, for example, where livestock are vital to the economy, the capacity of the land to sustain these livestock is diminishing. As grazing land deteriorates from overuse, it eventually becomes wasteland.

An Unhealthy Diet

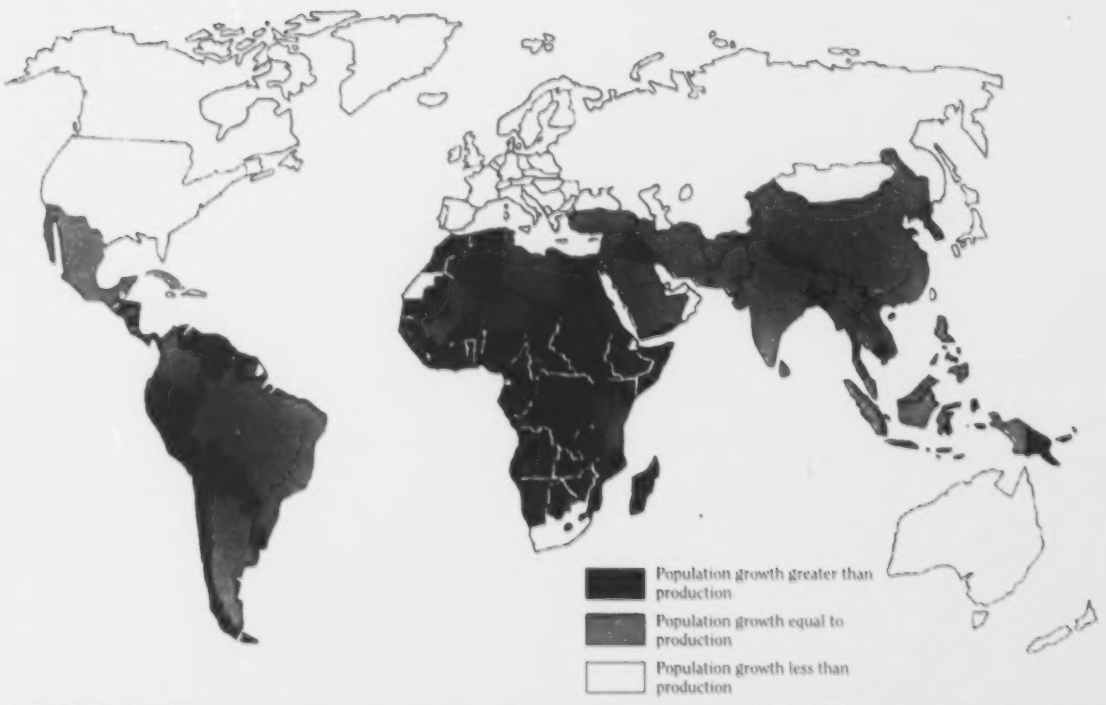
While livestock in many developing countries find less to eat on grazelands, American livestock eat well, consuming 80 percent of the corn and 90 percent of soybeans grown in the United States. One acre of prime land can produce 20,000 pounds of apples, 40,000 pounds of potatoes or 250 pounds of beef. In order to satisfy the North American demand for meat and dairy products, much of the U.S. prime land is used inefficiently, feeding animals, rather than providing food for the world's growing human population. Further, livestock production uses more than half of all water consumed for all purposes in the United States. It is estimated that 100 million people could be adequately nourished using the land, water and energy that would be freed from growing livestock feed if Americans reduced their intake of meat by ten percent. All of these facts amount to a compelling case that our diet choices have a substantial impact on land and environmental degradation, health, worldwide hunger and food distribution.

Rich farmland is also misused in many developing countries where large landowners grow "cash crops" such as cotton, coffee or tobacco instead of food. To the owners, land becomes an investment, not a source of food for the people who live on it. Meanwhile, 20 million people die each year of malnutrition.

Environmental Threats

Virtually all forms of global environmental degradation are adversely affecting food

Food Production and Population Growth


Population growth greater than production
Population growth equal to production
Population growth less than production

Marie Stopes International, London.

production. Damage to crops from air pollution and acid rain can be seen in industrial and developing countries alike. Global climate change, brought on by the production of greenhouse gases, poses other threats to crops. Scientists predict hot, dry summers ahead for America's breadbasket in the Midwest as a result of global warming.

Just as industrial practices threaten farmland, modern agricultural practices often pose threats to other ecosystems. The water pollution attributable to U.S. agriculture, including runoff of soil, pesticides and chemical fertilizers, is greater than all municipal and industrial sources combined. A growing demand for chemical-free produce in this country has led several farmers to experiment with organic farming practices.

A Sustainable Future

If we hope to alleviate the world food crisis, we must commit ourselves to sustainable agricultural practices. Sustainable agriculture means using the land in such a way as to safeguard its natural productive capacity for generations to come. It is not enough to focus on the most efficient and profitable way to grow food today. Ensuring that an ample amount of land will remain for tomorrow's food supply must also be our concern. For example, destroying rainforest to create cropland only provides productive land for a few years before topsoil erodes. Leaving the rainforests intact and harvesting renewable products, such as fruits and nuts, insures a steady stream of produce indefinitely.

With such finite cropland, we must use this precious resource judiciously. Diversification of crops, moderate irrigation, and responsible land management are just a few ways to produce food more sustainably. Eating lower on the food chain (substituting vegetables, fruits and grains for animal products) will allow us to use land more efficiently to feed more people. Better distribution of available food is also essential in preventing mass starvation in poor countries.

While there are multiple causes of global hunger, most experts agree that unless population pressures ease, a lasting victory over hunger will not be achieved. Feeding people adequately into the 21st century will depend on slowing world population growth to bring it in line with food production.

The Hunger Banquet

Student Activity 14

Concept: Much of the world suffers from chronic hunger and malnutrition due to population pressures and inequitable distribution of food and wealth throughout the world.

Objectives: Students participate in a luncheon which simulates inequities in the global distribution of food and wealth. Students discuss their reactions to the luncheon in a debriefing session.

Subjects: Social studies, family life, economics

Skills: Communication, bargaining, conflict resolution, strategic planning, writing

Materials:

(for a class of 30 students)
Food (see menu for items needed—you will need larger quantities of the "cheaper items", since most students will only be able to afford those)
3 tables (one buffet-style for food, two for eating)
1 tablecloth, and table furnishings (centerpiece, etc.)
10 chairs
275 "chips" (small squares of cut paper)
30 "1/2 chips" (small squares of a different color of cut paper)
14 visas (small cards marked "visa")
5 First World role-identity sheets*
5 Second World role-identity sheets*
20 Third World role-identity sheets*
30 menus (or one large menu posted for the class)*

* master is provided with this activity

Introduction:

This luncheon-game is meant to provide an experiential framework for understanding some of the inequities of the present socio-economic world situation and some of the feelings of helplessness and frustration that result from these inequities. By enabling the participants to deal with a concrete experience of built-in injustices, the luncheon can become a learning tool that goes beyond the merely factual. Through this experience, students will become more familiar with the concept of global interdependence.

Procedure:

Set-up:

1. The game is best played with at least 30 people, in order to have a visible proportion of rich and poor. You might use the following figures in proportioning your players and resources.

Area	Population Distribution	Players	Resources Distribution	Chips
First World*	15%	5	50%	38
Second World*	15%	5	30%	9
Third World*	70%	20	20%	2

** Economic classification based on per capita GNP as listed in the World Bank,* World Population Projections 1989-90 *(First World: $6000 or more; Second World: $2,000-$5,999; Third World: below $2,000).*

You will have to adapt these figures if you have more or fewer players, but you can base this on the population distribution. There should also be two people available for selling food and visas.

2. The game is prepared around the setting of a luncheon buffet. Feel free to adapt the menu provided.

   The food or buffet table should be made to look as attractive as possible. A beautifully furnished table and chairs should be placed in a removed and comfortable area of the room for the First World players. Provide a modest table and chairs for the Second World players. The Third World players should be confined to a small unfurnished section of the room, providing only chairs or sitting room on the floor. There ought to be a visible difference in the three settings.

3. Prepare envelopes for each student including a role-identity sheet and the proper number of chips according to the table above. Also, you might include a menu in each envelope. Extra chips can be used by the food and visa sellers for change.

Activity:

1. Give each player his or her materials. If you know the students, it might be a good idea to assure a strong personality in each of the three "worlds." Should you not know the players, simply give a set of materials to each player at random.
2. Tell the participants that:
   a) This is a simulation game approximating the distribution of purchasing power, population and food as it is in the real world.
   b) They are to deal with the situation as they see it, and enjoy the meal.
   c) There are no rules other than those on their role-identity sheet.
3. The dilemma of how to deal with the inequities of the food distribution may take various forms. For example: the group may immediately take on a "just and humane" style and work toward providing every player with an equal or adequate share of food. This is the "ideal" and will not necessarily happen. It might happen that the game results in "confrontation" or "revolution." In that case, it should be resolved by having the sides draw up a statement of "grievance" or "justification," etc. This should express both their feelings and their extended methodology for remedying the situation.

   The facilitator should use good judgment to surmise when the game has been played out and declare it over. At the finish, it is well to invite the players to drop the rules and share the food. However, you might judge it beneficial to let the inequality go unresolved. This would not be recommended if the session were to continue at any length.

MENU

Item	Size	Cost
Meat	1 slice	4 chips
Cheese	1 slice	4 chips
Salad	1 portion	3 chips
Bread	1 portion	1/2 chip
Pastry	1 portion	5 chips
Rice dish	1 portion	1 chip
Raisins	1 portion	1/2 chip
Cracker	1 portion	1/2 chip
Fruit	1 portion	3 chips
Tea	1 cup	1 chip
Juice	1 cup	2 1/2 chips
Milk	1 cup	1 chip
Sugar	1 tsp.	1/2 chip

Debriefing:

The debriefing session is very important and should be led by someone able to uncover people's reactions and synthesize their perceptions and insights. Also, after the group debriefing session, have students write about their personal experience and reactions. This should be a non-graded exercise that could either be handed in or shared in small groups. The debriefing should provide motivation for further in-depth study of complex problems related to the concrete global situation.

Suggested Questions:

1. What was your emotional reaction to the rules? To the rules of the other groups?
2. How did you feel toward the people in the other groups?
3. Did you agree with the manner in which your group resolved the problem? Do you think it was "realistic"?
4. Did your feelings change significantly during the experience? If so, when? Why?

Follow-up Activities:

1. Have your students investigate what is being done (or not being done) to redistribute food more equitably throughout the world. What is the role of the U.S. in providing food assistance? Of other developed countries?
2. Have students list ten things they can do as individuals to work towards more equitable food distribution worldwide.

Adapted with permission from the American Friends Service Committee. The original activity, "Simulation Game," appears in Hunger on Spaceship Earth, *The American Friends Service Committee, New York Metropolitan Regional Office.*

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Hunger Banquet Role-Identity Cards

Welcome to the First World . . .

You are a privileged citizen of the First World. You are part of the 15 percent of the world's population who lives in the "developed" world and you have almost unlimited enjoyment of the goods of the Earth.

You are invited to enjoy the luncheon we have prepared for you. You have been given 38 chips which entitle you and your fellow First World citizens to enjoy at least 50 percent of all that is being served.

Because you enjoy a high level of well-being, health, literacy and culture, you are granted an unconditional visa to travel anywhere you choose. However, each time you visit the Second World, you must donate 1 chip to the country, and each time you visit the Third World, you must donate 1/2 chip.

Don't forget your camera! Enjoy your day!

Welcome to the Second World . . .

You are a member of the "developing" peoples of the world, a citizen of one of the progressing industrialized countries.

You are part of the 15 percent of the world's people who use and control approximately 30 percent of the Earth's goods. You have been given a relative buying power of 9 chips. Please feel free to purchase whatever you can from the luncheon table.

Since you enjoy a minimum level of literacy and good health, you are free to travel to the First and Third Worlds under these conditions:

1) You must travel in pairs.
2) Your visa must be purchased at the luncheon table. One chip must be deposited at the luncheon table for each visa, and no more than two people may be issued visas at a time.

Don't forget your camera! Enjoy your day!

Welcome to the Third World . . .

You are hereby classified as a citizen of the Third World. Unfortunately, that will be of some disadvantage to your participation in this luncheon.

Since you comprise 70 percent of the world's population, it is not quite possible for you to have full freedom in consumption of the Earth's resources, or in fact, of our luncheon. You are entitled to about 20 percent of the Earth's goods and have been given a relative buying power of 2 chips. We encourage you to be enterprising and creative in your efforts to increase your buying power, perhaps through combining your chips.

Due to your high level of disease and illiteracy, we regret to inform you that your ability to travel is restricted.

Cost: Visa to Second World - 7 chips
Visa to First World - 9 chips

Visas may be purchased at the luncheon table.

Don't forget your camera! Enjoy your day!

Good News, Bad News-Where Do We Stand?

Student Activity 15

Introduction:

We hear all sorts of information about food issues from the media. Depending on what you read or hear at any one time, the situation related to population and food may seem good or it may seem bad. This activity allows data to be categorized as "good news" or "bad news." Then comparisons are made to determine some of the relationships between the data we often only evaluate piecemeal.

Procedure:

1. Ask the students if they are pessimistic or optimistic about the chances of feeding the world and slowing rapid population growth.
2. Tell them that you would like them to rate some statements of fact. Have them decide whether the statement is, in their own judgment, "good news" or "bad news." Have students draw a line down the middle of a piece of paper and label one column "Good News" and the other column "Bad News." They should then copy each statement or statement number in the appropriate column.
3. Have students discuss the ratings. You might identify some statements and discover to what degree the students agreed on the rating for each statement.

   Then, discuss these questions:

   a) Are there statements in one column that make another statement seem better or worse?

   b) What other statements make a statement seem much better or much worse?

   c) Take a statement and draw lines to the other statements on the list which affect it.

   d) Does the data confirm your pessimism or optimism? Why?
4. Ask the students if they have changed their minds about the ratings. Encourage them to collect more information that will help them evaluate the prospects for positive solutions to the population/food dilemma.

Follow-up Activities:

1. Have students write an opinion paper on the following statement: *With modern technological know-how, the world will/will not succeed in feeding its people in the future.*
2. Make a bulletin board with two sections —"Good News" and "Bad News." Have students bring items such as articles and graphics to place on the board. Let the group discuss the new information as it becomes available. This points out the continual process of data collection and attitude evaluation.

Adapted with permission from the University of Denver Center for Teaching International Relations. The original activity, "Good News, Bad News," appears in Teaching About Population Issues *by George Otero, Jr. and Richard Schweissing, Center for Teaching International Relations, University of Denver, CO, 1977.*

Concept: When studying global issues such as population growth and food availability, we must refer to a number of data resources to get a clear picture of the situation.

Objectives: Students determine whether given statements on population growth and food issues are "good news" or "bad news." They then compare data to identify relationships and shape their evaluation of population/food issues.

Subjects: Social studies, environmental science

Skills: Evaluating and ranking data, critical thinking, data collection, writing

Materials:

Duplicate the list of statements on the following pages for each student.

Good News, Bad News-Where Do We Stand?

STATEMENTS

1. Some countries are paying their farmers not to produce food.
2. Sixty-eight nations are more than three times as crowded as the United States.
3. Much potentially arable land must be irrigated.
4. Tropical land receives greater solar radiation, and multiple crops could be raised each year on this land.
5. The soil in many tropical areas is very poor and erodes easily.
6. Infant death rates are dropping in almost every country in the world.
7. Most nations of the world now have family planning programs.
8. Many of the new high-yield varieties of grains have lower protein content than pre-World War II varieties.
9. Research is now concentrating on developing and testing grain varieties with higher protein content as well as possible additives to enrich the present varieties.
10. The population of the world is growing by 95 million people each year.
11. Life expectancy has increased in most parts of the world.
12. There are more hungry mouths in the world today than ever before in history.
13. The use of improved seed lines, water control, more fertilizer, and disease and pest controls have together brought about sharp increases in grain production around the world.
14. The United States has five percent of the world's people and consumes almost 30 percent of the world's resources.
15. A map of the cultivated land on our planet shows Eastern and Central United States, Europe, the Soviet plains, India and China to be the major cropland areas; the best, by far, are those of the American Midwest.
16. Most countries, including the United States, are running out of land that can be converted to cropland.
17. Land not under cultivation will require immense inputs of money for clearing, irrigation, and fertilization to make it productive.
18. Much productive land is used for non-nutritive crops such as tobacco and coffee.
19. The food that is annually lost in India to pests, poor storage, and poor transportation could feed 50 million persons.
20. Less than five percent of the soils of the tropics are potentially fertile cropland.

21. Some poor Americans have been reduced to buying pet food as a source of protein.

22. There's a booming trade in the United States in vegetarian cookbooks.

23. It takes 400 billion dollars to build up an inch of topsoil.

24. Annual consumption of red meat and poultry combined is at an all-time high in the United States.

25. Nearly 40 percent of the world's total grain is fed to livestock.

26. From 1965 to 1990, world cereal production increased over 70 percent and more than doubled in developing countries.

27. Without a major expansion of arable land, the world average of 0.28 hectares of cropland per capita (2,800 square meters) is expected to decline to 0.17 hectares by the year 2025 if current population projections hold true.

28. In Asia, an estimated 82 percent of potential cropland is already under production.

29. Cropland expansion will most likely come at the expense of rangeland, forests, wetlands and other areas that are both economically important and ecologically fragile.

30. The number of calories available per person in 94 developing countries rose from 1,940 per day in 1961-63 to 2,460 per day in 1984-86.

31. Between 1970 and 1985, the estimated number of malnourished people throughout the world increased by over 50 percent.

32. About 5 percent of U.S. farmers are cutting back on chemicals and adopting alternative farming practices that are both economically and environmentally beneficial.

33. Average annual marine catch worldwide increased by 30 percent from 1975-77 to 1985-87.

34. India more than tripled its grain harvest between 1965 and 1983. Since then, grain production has not increased.

35. By the year 2000, India is expected to have approximately one billion inhabitants.

36. Waterlogging and salinity are lowering productivity of one-fourth of the world's irrigated cropland.

37. Each year, the world's farmers lose an estimated 24 billion tons of topsoil from their cropland in excess of new soil formation.

38. Many widely used pesticides and herbicides are toxic. The runoff of these chemicals can contaminate groundwater and endanger wildlife.

39. Enough grain is currently grown worldwide to feed six billion people on a no-meat diet.

40. An estimated 950 million people had deficient diets in 1988.

Waste Disposal

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What A Waste!

Student Reading

When it comes to garbage, North Americans hold the singular distinction of producing more garbage per person than those in any other country in the world. In 1960, the average North American produced two and a half pounds of garbage per day. Since then, the population has grown by 70 million people, and we have developed into a "disposable society" that now produces more than three and a half pounds of garbage per day per person. Although other countries are more waste-conscious, disposal of solid waste is a global problem. Several methods have been created to alleviate the disposal situation, but few have been implemented without opposition due to hazardous environmental side effects.

According to the Census Bureau, the U.S. population will increase by 20 million by the turn of the century. Those additional people, based on current behavior patterns, will generate 80 million tons of trash by the year 2000. This is enough trash to fill a convoy of ten-ton garbage trucks wrapped around the Earth almost three times—about 70,000 miles. Whether it is burned, recycled or buried, the fate of refuse has major impacts on health, the environment and the economy.

All Full Up

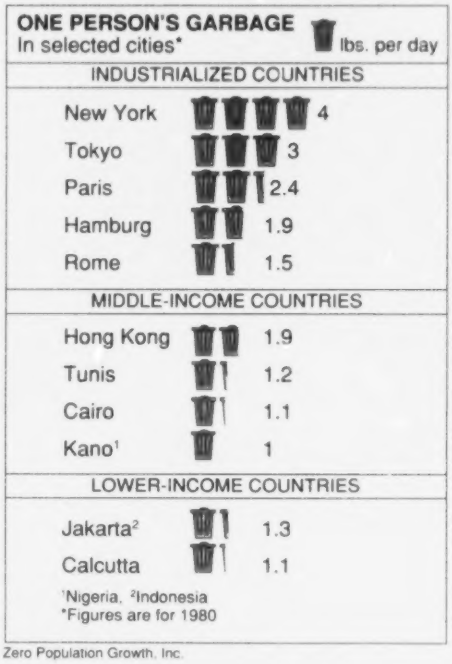
Approximately 80 percent of U.S. garbage is presently buried in landfills. Landfill disposal is a method whereby all types of garbage are placed into a pre-built hole in the ground. Our current landfills are rapidly running out of room. A recent study by the U.S. Environmental Protection Agency showed that almost a third of the 6,500 landfills currently operating will close within a few years. Environmental problems caused by landfills have surfaced in the last decade. When water filters through a landfill, dangerous materials can form and leak into groundwater supplies. New environmental regulations have been created to counter the problems. But this legislation has made landfills more expensive to build.

Additionally, as the population continues to grow, the demand for land for other purposes—housing, parks and roads—increases. Consequently, landfill problems are most severe in areas of high-density population, such as New Jersey and Florida. These two states will have to close all their landfills by the end of the century. They have already begun to deal with this problem by attempting to send garbage to other states for disposal. This practice is becoming increasingly more difficult because many communities are unwilling to accept garbage. In the mid-1980s, a barge of 3,186 tons of Long Island waste was rejected by six states before it was finally incinerated several months later.

Burn It Away

Incineration is the burning of wastes with gases and ash as end products, and has been in existence since the Industrial Revolution. During the 1960s and early 1970s, many incinerators were forced to shut down due to a lack of required pollution control equipment. In the 1980s, incineration experienced a growth spurt after the development of "cleaner burning" technology. Today, in the United States, approximately 10 percent of solid waste is incinerated, and that figure is expected to increase as new incinerators are put into operation.

Incineration has several disadvantages. Garbage is not an efficient fuel. Burning garbage does not generate as much energy as would be saved through recycling. Additionally,



Zero Population Growth, Inc.

incineration is not the final disposal because the primary waste (garbage) has merely been converted into secondary waste (gases and ashes) which then needs to be treated in some way to ensure safe storage. When garbage is burned, the remaining products are about 30 to 40 percent of the volume of the raw garbage. Tests show that all incinerator ash contains potentially hazardous concentrations of toxic metals and chemicals. The resulting gases and ashes are often more hazardous to public health and the environment than the original garbage.

Reduce, Reuse, Recycle

A safe, clean way to reduce the garbage problem is to recycle materials, thereby decreasing the amount of waste that needs to be stored or incinerated. Recycling is the separation of waste, which is sent to a recycling center and then reintroduced into the marketplace as useful raw material. The overall aim of recycling is to decrease the amount of materials that enter and exit the economy. As the landfill crisis worsens, recycling is becoming an accepted component of waste management.

Most materials used today are discarded after one use. Many do not realize the amount of energy and money saved by reusing and recycling materials. Only five percent as much energy is needed to recycle aluminum as to produce it from bauxite, the original raw material. There is a two-thirds energy savings for recycled steel, compared to steel produced entirely from scrap. Newsprint from recycled paper takes 25 to 60 percent less energy to make than that from wood pulp.

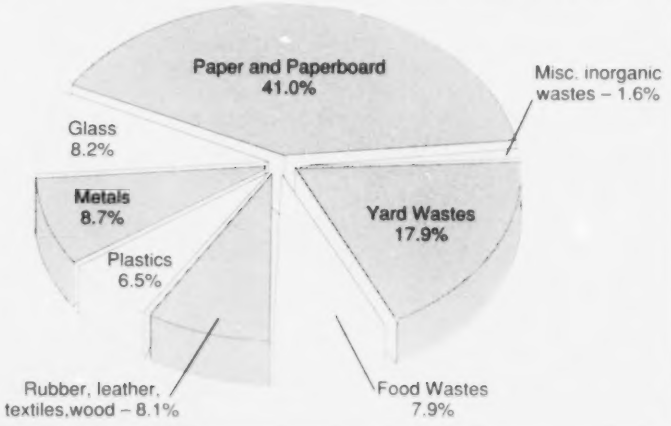
In addition to the savings of energy, recycling has a beneficial effect on air, water and land quality. Steel produced from scrap reduces air pollution by 85 percent and water pollution by 76 percent, and eliminates mining wastes completely. Paper from recycled material decreases air and water pollutants by 74 and 35 percent respectively.

In the United States, approximately 10 percent of municipal waste is recycled. Paper and cardboard, the single largest component of municipal solid waste, could be recycled, but instead, about 65 percent is thrown away. The United States recycles 25 percent of the paper it consumes annually. In comparison, Sweden and Switzerland recycle 40 percent and Japan recycles 50 percent, including 93 percent of its newspapers. Each ton of recycled paper saves 17 trees, 25 barrels of oil, 7,000 gallons of water, and three cubic yards of landfill space.

Along with recycling glass, metals and paper, a sustainable society also recycles nutrients. Individuals can recycle nutrients by composting their food scraps. Composting not only reduces waste, but produces a rich fertilizer.

Individuals can also reduce solid waste by exercising their environmental purchasing power. Packaging accounts for as much as half the volume of household waste. By selecting items that are efficiently packaged, especially with recyclable or reusable materials, people can substantially reduce levels of waste.

U.S. Materials Generated in Municipal Solid Waste by Weight



Keep America Beautiful, December 1989

Wasting Away

It is important to realize that when we dispose of waste, we are not really throwing it "away." We are only displacing it from one area (our homes) to another (landfills or incinerators).

In the long run, source reduction produces the most environmentally sound and cost-effective way of dealing with our growing solid waste problem. Successfully reducing waste requires a change in lifestyle, based on a conservationist mindset, rather than a disposable one. However, unless steps are taken to stabilize population size, even our most aggressive efforts to recycle, reduce or reuse waste will be continually undermined.

Talkin' Trash On Tropico

Student Activity 16

Introduction:

Disposing of the solid waste created by an expanding population has become a dilemma facing many communities today. The average American generates nearly four pounds of garbage a day, which quickly adds up to a storage problem, especially in urban centers and areas with a high concentration of people. Simply carting everything off to the local landfill is no longer a feasible option for much of the country. In the following activity, students will set goals for a waste disposal program, form committees to research options, and then meet together to work on an acceptable implementation plan.

Procedure:

1. Explain that students will represent a steering committee for Tropico, an island faced with waste disposal problems. The island's population has been growing at a rapid rate, doubling in the last 25 years from 28,000 to 56,000. Simultaneously, the consumption patterns have risen due to an increased standard of living and greater use of disposable products. The modest local landfill could not keep up with the ever-increasing flow of trash and was forced to close because of health hazards and an overflow problem.

   The class must first outline the goals they want to achieve with their plan. Emphasize that they will need to plan for the long term (at least 10 years) and should try to balance environmental and economic concerns. Also, remember that the amount of garbage generated may increase from continued population growth or decrease from better habits by individuals and businesses.

2. The students should form groups to research different parts of an effective waste disposal plan. Each group should fill out the Student Worksheet and make a final recommendation about the role their method should play in the final program. Research may be done in the library, or by contacting local waste disposal services and organizations such as Keep America Beautiful (see "Resources" section on the following page for a list of potential sources). To decrease the amount of class time needed for this activity you may want to collect the information from these organizations a few weeks before the activity begins.

   Groups should be formed to research the following areas:

   a. Reducing the amount of waste generated (e.g. tax incentives for less trash per household or restrictions on packaging consumer goods).

   b. Various recycling programs, and the feasibility of each. (The success of recycling programs usually depends on a steady stream of the goods to be recycled, and a demand for the end materials.)

   c. Composting, and how it might work for a portion of the island's garbage.

   d. Incineration or "waste-to-energy" as an option.

   e. Building a new landfill, using the most environmentally and monetarily sound safety features. (Even if the other options are utilized, a landfill will still be needed for non-recyclable, non-burnable, non-compostable items and ash from incineration.)

3. After the groups complete their worksheets, the class should meet to decide how the recommendations will fit together to form a cohesive program for the island. A spokesperson from each group should report on the group's findings and give a recommendation. Remember to keep the long-term goals in mind while debating which options to emphasize. If the class cannot agree on one combination of options, you could pick the two or three most popular proposals and have the class vote.

4. Once the program is determined, the class will also have to choose locations for the implementation of different parts of the plan. At this point, some socio-economic considerations will come into play. The island's indigenous LoLi tribe are in desperate need of money and are willing to host recycling stations, incineration plants or the new landfill on the land allotted to them by the government. The price they are asking is only about half of the price of placing these options in other areas of the island. In exchange for the low price, they

Concept: As the population increases, so does the amount of solid waste produced, creating a dilemma of how and where to dispose of the garbage.

Objective: Students will weigh the advantages and disadvantages of various waste disposal options when deciding how to manage the waste of a growing island community.

Subjects: Environmental science, economics

Skills: Research, writing, evaluation, cooperation, decision making

Materials:

Research materials about solid waste (see resource list on the following page)
Copies of Student Worksheet

are asking that the new jobs generated by these options be reserved for their people. However, as the student worksheets indicate, some of the projects involve more health risks to local populations than others.

Also of consideration is the potential contamination of the drinking water. You want to keep the lake free from toxins and preserve groundwater as well. The class will need to weigh the moral, environmental, and economic arguments of the placement of the different facilities.

Follow-up Activities:

1. This activity would have different results if the island had other characteristics. You may want to try a version where groups research varied types of islands. For example, one could be close to Miami, use a lot of plastic, and be able to ship recyclables to the mainland. Another could be a popular tourist spot, with large amounts of waste and income. A third could be very remote and use mostly organic products.
2. Ask students to think of other options to dispose of the waste (e.g., dump it in the ocean or send it to another island). What are the major drawbacks of these? Try to get students to realize that many options only temporarily solve the problem.
3. Remind students that the island's population doubled in the last 25 years. Will their plan be able to incorporate another doubling in the next 25 years? How about the next? How could this problem be handled?
4. Students should also find out about the methods of disposing of solid waste in their community. How much of the waste is being recycled? How much longer will the local landfill be able to operate? Students can get a first-hand look at where their garbage goes by taking a field trip to the local landfill and other facilities and speaking with the people who run the programs.

Resource List

Garbage Magazine
Old House Journal Corporation
2 Main Street
Gloucester, MA 01930
508/283-3200

Resource Recovery
National League of Cities
1301 Pennsylvania Avenue, NW
Washington, DC 20004
202/626-3000

Resource Recycling: North America's Recycling Journal
P.O. Box 10540
Portland, OR 97210
503/227-1319

Tennessee Valley Authority
Waste Technology Program
Forestry Building
Norris, TN 37828
615/632-3023

Keep America Beautiful
Mill River Plaza
9 West Broad Street
Stamford, CT 06902
203/323-8987

The U.S. Environmental Protection Agency
Office of Solid Waste
401 M Street, SW
Washington DC 20460
202/382-4610

National Solid Waste Management Association
1730 Rhode Island Avenue, NW
Suite 1000
Washington, DC 20036
202/861-0708

Environmental Defense Fund
257 Park Avenue South, 16th Floor
New York, NY 10010
212/505-2100

Talkin' Trash On Tropico

Student Worksheet

You will be developing a new waste disposal plan for Tropico, a fictitious island community. The island is 22 square miles, has a population of 56,000 and generates an average of 112 tons of solid waste daily. The waste stream is similar in composition to that of the average town in the United States: 40 percent paper products, 18 percent yard wastes, 7 percent glass, 9 percent metals, 7 percent food waste, 8 percent plastics, and the rest "other" wastes. Working in small groups, you need to research the feasibility of the options assigned to you and complete the following worksheet. Whenever possible, find out specific information such as how much land the option you are researching will need to operate, how much of the solid waste stream can be disposed of with your option, how much room the program could save in a landfill, and in what kind of area your program should be located.

Disposal plan:

Description of option:

Benefits: Environmental Economic Convenience

Drawbacks: Environmental Economic Convenience

Recommendation:

Talkin' Trash On Tropico

MAP

The Island of Tropico

Most of the inhabitants of Tropico live at the end of the island where the freshwater river empties into the sea. A native tribe lives on government land at the other end of the island, and tends to have a lower standard of living than the rest of the population. In the center of the island lies a freshwater lake from which the river flows; both the lake and river are used by the islanders for bathing, drinking and washing.

McFoam or McPaper: The BigMac Wrap Debate*

Student Activity 17

Introduction:

With landfill space diminishing at an alarming rate, environmentalists have urged manufacturers to reduce solid waste, often by changing packaging materials. McDonald's, the world's largest fast food chain, teamed up with the Environmental Defense Fund (EDF) to do just that. In late 1990, McDonald's announced that, with the help of EDF, they would switch from polystyrene "clamshell" containers to paper to wrap their hamburgers and other food items.

Following the McDonald's announcement, a consulting firm representing the plastics and polystyrene industry released a report claiming that polystyrene containers are less damaging to the environment than paper containers. The report cited the greater amount of energy and natural resources used to produce paper containers and the greater environmental impacts of incinerating these paper products. Further, the polystyrene industry claimed that after use, their product has greater recycling potential than the paper product.

Procedure:

1. Divide the class into three groups. Group #1 will research and debate the claim that McDonald's made a wise decision in switching to paper wraps since they cause less environmental damage. Group #2 will refute the claims of Group #1, arguing that the use of polystyrene containers is safer to the environment and McDonald's made a big mistake. Group #3 will decide which containers are preferred after hearing arguments from both sides.
2. For their research, Groups #1 and #2 should contact individuals and organizations representing each side of the issue. In addition to contacting the EDF and the Polystyrene Packaging Council, students might seek out local waste management experts, fast food restaurant personnel and environmentalists in their area. They will then be equipped to form convincing arguments for the debate. Group #3 should prepare questions for the debaters in the other groups. The point of their questions should be to elicit information which will help them make their final decision.
3. On the day of the debate, set up a table or podium in the front of the room. Members of Group #3 will have their desks in the front row facing the podium. Each of the other two groups will have their desks together behind Group #3.
4. Groups #1 and #2 will flip a coin to see who will begin the debate. A representative from each group will have two minutes to make an opening statement. From that point on, members of Group #3 will alternate posing questions to each group to help them make their final decision on which container is better for the environment. When a question is posed to one group, a representative from that group will have one minute to respond. If the other group wishes to give a rebuttal, one of their representatives may do so, but will also be limited to one minute. In order to involve as many students as possible, students in each group should take turns answering and rebutting questions.
5. You may wish to limit the questioning to ten or fewer questions. Members of Group #3 should take notes on the answers they receive and on how convincing the debaters are in framing their arguments. It might be helpful for Group #3 to divide note paper into two columns to list points and counterpoints.
6. After the debate, Group #3 should convene to decide the winner. Their decisions should be based not so much on the oratorical skills of their classmates as on the persuasiveness of their arguments. Once a decision has been reached, Group #3 should report this to the class, including a summary of why they reached their decision.

Follow-up Activities:

1. What materials do other fast food restaurants use for their containers? Have students find out. They can express their support or disapproval of these practices based on their research and discussion. Their research will aid them in preparing a well-thought-out letter of support or disapproval to the management of a fast food chain.
2. As an alternative to debating about environmentally sound materials for fast food containers, students could take on the diaper dilemma (cloth vs. disposables). The

Concept: Environmental issues are often quite complex. Critical thinking skills are essential in determining which practices are the most environmentally sound and cost-effective.

Objective: Students will debate which fast food container, polystyrene or paper, has a greater environmental impact when used widely throughout the United States.

Subjects: Environmental science, language arts, family life

Skills: Critical thinking, debate, research, writing, public speaking

Materials:

Helpful research materials include articles written on the debate between paper and foam, as well as position papers from interest groups:

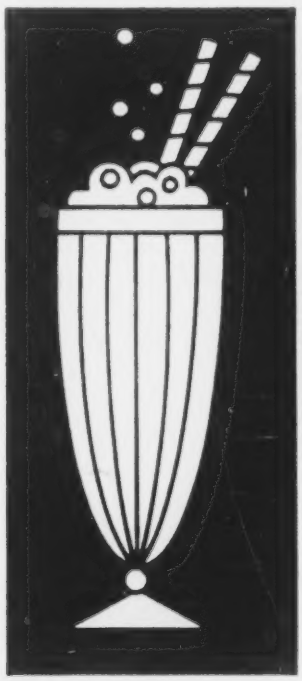
Environmental Defense Fund
1616 P Street, NW
Washington, DC 20036
202/387-3500

Polystyrene Packaging Council
1025 Connecticut Avenue, NW, #508
Washington, DC 20036
202/822-6424

National Association of Diaper Services advises that parents use cloth diapers and not add more disposables to the overcrowded landfills. Procter and Gamble, makers of disposable diapers, claim that the use of their product consumes much less energy and generates fewer water pollutants than reusable cloth diapers. This continuing debate leaves parents very confused as to how to cover their babies' bottoms while still protecting the environment.

Another debate is being waged between the plastics industry and the paper industry over the preferable material for grocery bags. These topics might also include the validity of new "biodegradable plastic" materials.

**BigMac is a registered trademark of McDonald's.*



Waste A-Weigh

Student Activity 18

Introduction:

The U.S. population constitutes only five percent of the world's population, but consumes 28 percent of the world's energy. This heavy use of resources creates a steady stream of solid waste to be handled by waste disposal services. As the population grows, so does the burden on these services. One immediate way to reduce this burden is to modify habits which generate excess waste. Students will learn about using more sustainable practices in their daily lives in this activity.

Procedure:

1. On the Friday before you plan to do the activity, tell the class that they will participate in an experiment concerning waste production during the following week. Explain that the waste students generate during lunch will be recorded for the entire week. Encourage students to bring or buy their usual lunch on Monday in order to gauge their conservation progress as their awareness of their consumption patterns grows throughout the week.
2. Each day of the following week, set up a weighing station in the cafeteria and require all your students to weigh any items that they plan to throw away, including food wastes, packaging, bottles, etc. Record the weight of each student's trash, and later transfer the amounts to a chart in your classroom. This chart should also include the total weight of all trash generated by the class that day.
3. Sometime during the beginning of the week, you might want to give students hints on how to reduce their waste. Suggestions should include: only buying as much food as they plan to eat, avoiding items with excess packaging, bringing reusable containers from home, and recycling glass, aluminum and plastics.
4. At the end of the week, have each student fill out the worksheet included with this activity. Ask students which conservation methods seemed to be most effective. Which were most convenient? Which do they think would be best to implement on a school level? On a community or city level? Nationally? Also, have students brainstorm about specific ways the practices in their cafeteria could be changed (e.g., see if the art department would like some of the containers, check whether recycling is done whenever feasible, compost the food waste, or see if local farmers could feed it to animals).

Follow-up Activities:

1. With the data in front of them and some new ideas, students may feel challenged to try to reduce waste during another week of testing. They can be encouraged in their efforts by the story of one student who carried his brown paper bag home every day to use again the next. He put a mark on the bag for each trip he made. By the time the bag was too torn to use again, it had carried his lunch to school 32 times.
2. Once students have learned conservation techniques for themselves, they may also wish to challenge another class to a competition to see who can average the least amount of waste. The competition could be expanded to different grade levels, or even different schools in the area. Local newspapers and magazines might be interested in featuring such a competition in their publication, especially with suggestions from students about ways for the community to decrease waste generation.

Concept: Changing careless consumption patterns can help reduce the pile-up of garbage contributing to current waste disposal problems.

Objective: By weighing and recording their waste at lunch every day for a week, students learn how conservation efforts can impact the total amount of trash generated.

Subjects: Environmental science, biology, family life

Skills: Practicing conservation, brainstorming, collecting and recording data

Materials:

A scale to weigh the garbage (you might want to pre-adjust it with the weight of one cafeteria tray and place the trash on the tray)

Copies of Student Worksheet

Waste A-Weigh

Student Worksheet

	Monday	Tuesday	Wednesday	Thursday	Friday
Personal waste:	_____	_____	_____	_____	_____
Class waste (total):	_____	_____	_____	_____	_____
Class average (per person):	_____	_____	_____	_____	_____

Did you have more or less waste than the class average?

Did you create more or less waste as the week went on? What about the class?

If less, how much less? (subtract the last day from the first to discover the amount saved)

You _____

Class _____

If your class could reduce garbage by ten percent, how much garbage would be avoided? How much garbage would be avoided if your whole school conserved at this rate?

	CLASS	SCHOOL
In one day?	_____	_____
One month?	_____	_____
The school year?	_____	_____

Wildlife Endangerment

Answering the Call of the Wild

Student Reading

Long before Homo sapiens walked the Earth, the planet belonged to an enormous array of mammals, reptiles, insects, fish, birds and plants. From the tiniest amoeba, these species evolved over hundreds of millions of years into a rich collection of flora and fauna. But in just the past few decades, untold numbers of plant and animal species have disappeared forever from the Earth and many more are threatened with extinction.

Scientists have named 1.4 million species of plants and animals, but estimate that between five million and 30 million share our planet. At the present rate of extinction, 20 to 50 percent of these known species will be lost by the year 2000. And, by the early 21st century, we could witness several hundred extinctions per day.

Human Homewreckers

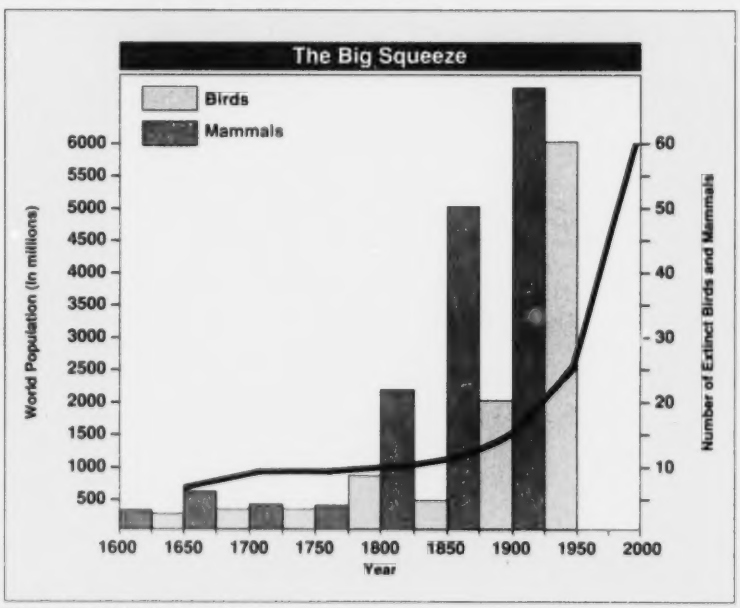
Extinction and endangerment occur for a variety of reasons. Some species are lost through natural occurrences. No one knows why the dinosaurs became extinct about 60 million years ago or what happened to the great mammals 10,000 years ago. Certain animals and plants may die out in our own time regardless of what we can do for them. Extinction is a fact of life on Earth. However, premature extinction caused by human activities can and should be prevented.

The endangerment of species does not usually result from natural occurrences. Human intervention can have detrimental effects on a species in several ways. Growth in human population takes its toll as natural habitats are paved over, built on, polluted, lumbered and mined—all to "benefit" encroaching civilization. Destruction and degradation of habitat are common threats to wildlife. Most ecologists agree that reducing the size of a natural habitat increases species' risk of extinction. Timber clear-cutting, mining, farming, hunting and the conversion of open space into commercial and residential developments have squeezed many of our native plant and wildlife species into smaller and smaller areas. The destruction of a plant species is extremely serious, as it can harm an entire ecosystem. In the words of biologist Paul Ehrlich, "Every time we remove a plant species, we probably eliminate something on the order of ten animal species."

Although all habitats play a role in the biosphere, the tropical forests are especially precious. Of the 1.4 million species that we know of on the Earth, more than half live in tropical rainforests. Considering that 40 percent of the tropical forests have already been destroyed, the enormity of the destruction, in terms of both number of acres and number of plant and animal species, is staggering. Population growth and the accompanying consumption of energy and resources are responsible for much of this decline in species diversity. As the Earth's population continues to increase, more land is used for agriculture and development, destroying crucial wildlife habitat.

The clash between humans and wildlife is evident in virtually every part of the United States as well. Consider Florida, where each week some 10,000 people move into the state, crowding out such native species as the manatee and the Florida panther. The dwindling manatee population falls victim to propeller blades on power boats while looking for vanishing seabeds for grazing. The nearly extinct panther has lost its home to subdivisions, citrus groves and other development.

Wetlands, an ecosystem which supports a vast and beautiful array of wildlife, are also a



Source: National Wildlife Federation

focus of concern in the United States. Of the list of U.S. endangered or threatened species, experts estimate that about 45 percent of the animal species and about 25 percent of the plants listed use wetland habitat. But the nation's wetland acreage has been shrinking rapidly in recent decades as it is drained for agriculture, industry, shopping malls, housing subdivisions and other development, or dredged for transportation or other purposes. The United States has already lost over 54 percent of its original wetlands.

Human technology, too, has adversely affected certain species. In parts of the western United States, eagles are electrocuted when they perch on power transmission poles. In Florida, hatching sea turtles are lured into cities, mistaking the reflected city lights for the starlit sky over the ocean.

In 1973, the U.S. government attempted to protect threatened wildlife by enacting the Endangered Species Act. This legislation, along with related acts such as the Marine Mammal Protection Act of 1972, was designed to protect species that were deemed threatened or endangered in the United States. Although this legislation has been instrumental in saving some species, it has not been completely effective. The list of endangered species recognized under the U.S. Endangered Species Act grew from approximately 380 when the law was passed in 1973 to 1,056 in 1991.

Polluting the Ark

Humans have another devastating influence on wildlife—pollution. Birds, mammals, fish, shellfish and their food sources are all vulnerable to human-generated poisons dumped into fresh and marine waters. Bottom-dwelling organisms like shellfish, which spend all of their lives in coastal water or estuaries, are at serious risk of contamination by bacteria and biotoxins, and of death from oxygen depletion.

The Chesapeake Bay, for instance, was the nation's most productive estuary. Now the pressure of population has turned the Chesapeake into a catch basin that collects the refuse of 5,000 pollution sources, including factories, farms and sewage treatment plants. Runoff from lawns, roads, parking lots and farmland carries pesticides, petroleum and other toxins into the bay. These wastes have reduced the Chesapeake's seafood catch to a shadow of 19th-century levels.

Killing for Profit

Wildlife extinction is not only the unfortunate byproduct of human growth. Throughout the world, creatures are willfully murdered for profit. Many of the world's most beloved animals, such as gorillas, rhinoceros and elephants, are victims of poaching—the practice of illegally killing an animal, usually for some precious body part. The World Wildlife Fund reports that the African elephant

population has dropped by 75 percent since 1970 as a result of poaching. In the case of the elephant, it is the ivory that is prized. Many other species fall victim to the same fate, so that alligator handbags and rare fur coats can be sold on the black market.

Regulations have not been effective enough to save many of the world's creatures. A little over two decades ago, the blue whale population was estimated at 11,000. Today, despite an international ban on commercial whaling, there are only between 200 and 1,100 blue whales. The population before modern commercial whaling was about 250,000.

Key to Our Survival

Although humans are responsible for endangering so many plant and animal species, we depend on other species for our very survival. The planet's biodiversity provides the world with crucial "ecosystem services"—clean

water, a breathable atmosphere, and natural climate control—upon which all species depend. The extermination of plant populations can change the climate locally and can also have severe regional effects through disturbance of the water cycle. Food, medicine and shelter are all derived from the abundant organic resources of the Earth. More than a quarter of the prescription drugs on the U.S. market are derived from natural plant species. Some of these drugs are used to fight cancer, malaria and heart disease.

Additionally, loss of biodiversity deprives us of tools that might help in the struggle to feed ever-increasing numbers of people. For example, only a few of the more than a quarter million kinds of plants that exist have been investigated for their potential as crops. Many other opportunities for creating new foods and medicine exist and are awaiting discovery and development. However, continued destruction of the tropical forests over the next few decades promises to permanently remove virtually all possibility of benefiting from this resource.

Out of the vast array of species inhabiting the Earth, humanity uses only one-tenth of one percent. The potential for the other 99.9 percent is enormous and mostly unexplored. However, with every species that is driven to extinction, we lose some potential to cure disease, improve crop productivity, and enhance our standard of living.

The World Wildlife Fund reports that twenty years ago, species became extinct at the rate of one per day. In 1990, that rate increased to one per hour. With the aid of public education, people of the United States and other countries need to realize the serious ramifications of these daily losses. Unlike many things in our lives today, once a species is gone, it can never be recreated.

Bye, Bye Birdie

Student Activity 19

Concept: The rate of wildlife endangerment is increasing. Difficult decisions are required to determine which species can and should be saved.

Objectives: Students will determine which factors should be considered in deciding the fate of endangered species. They will then research one endangered species and prepare a short presentation, justifying the preservation of the species.

Subjects: Biology, environmental science, language arts

Skills: Critical thinking, cooperation, library research, writing, evaluation, public speaking

Introduction:

Humankind is now precipitating the extinction of large numbers of animals, birds, insects and plants. In 1970, species became extinct at the rate of one per day. By 1990, species were becoming extinct at the rate of one per hour. At the present rate of extinction, 20 to 50 percent of all known species existing in 1991 could be lost by the year 2000.

Scientists believe that many of the species being lost carry untold potential benefits for the health and economic stability of the planet. With limited funding available for conservation, tough choices must be made as to which species can and should be saved.

In the following activity, students will develop a method for making these tough choices on wildlife preservation and compare the relative "value" of different species.

Procedure:

1. Before beginning the activity, discuss with the class the importance of biodiversity. Emphasize that biodiversity provides us with many products (especially pharmaceutical), as well as crucial "ecosystem services," such as clean water, breathable air and natural climate control. Then, working individually or in pairs, have students determine which factors should be considered before a decision is made to save a species or let it become extinct. They should list each reason they think is important and write a one-paragraph defense of each argument.
2. Students will now apply the criteria they developed. Working individually, students should "adopt" one of the endangered species listed on the next page (make sure that each student chooses a different species). Give them time to research information about their species in the library.

   Students should prepare a short presentation which describes the species, states its importance, and gives reasons why it should be preserved. They should also discuss threats to the species' survival. These might include human destruction of habitat, poaching for economic gain, disease, adaptability to climate change, population increase of predators, etc. Depending on the amount of information available, some students may have to substitute a similar species when conducting their research.
3. Divide the class into groups of 6-8 students. Students in each group will present their findings on their adopted species to the group. As the presentations are made, students should rate each species using the criteria developed in the first part of the activity. Ask students if they would change the criteria they developed earlier after they researched their species and rated the others. Have students explain the changes they would make.
4. As the final part of the activity, students must decide which species they will "save" and why. Analysis should focus on the relative possibility of success, examine the economic value of the species, and include less concrete factors such as the preservation or loss of beauty. In addition to the individual ratings, each group should try to reach a consensus on which species should be "saved" with the limited resources available.

Follow-up Activity:

There are many endangered species of plants and animals throughout the United States. Students can write to the U.S. Fish and Wildlife Service (18th and C Streets, NW, Washington, DC 20240) or your state fish and game agency to obtain a list of threatened or endangered species in your area. Contacting a nearby nature center or natural history museum might also provide helpful information. Once students know which species are endangered in your area, they can research whether or not any efforts are being taken to protect the endangered animals or plants. Preservation projects could be initiated through your school, scouts, 4-H, nature clubs, or hunting and fishing clubs.

Adapted from Global 2000 Countdown Kit, *Zero Population Growth, Washington, DC, 1982.*

Selected List of Endangered Species

Species	Habitat
Giant panda	China
Hyacinth macaw	Brazil
Blue whale	Oceania
Black rhinoceros	Africa
American burying beetle	North America
Bobcat	Mexico
Attwater's prairie chicken	Texas
Orangutan	Borneo and Sumatra
Kirtland's warbler	Michigan
Snow leopard	Central Asia
Everglade kite	Florida and Cuba
Gray wolf	United States
Chinchilla	Bolivia
Spotted owl	United States
Indian python	India
Whooping crane	North America
Birdwing pearly mussel	United States
Asian elephant	Southeast Asia
Cheetah	Africa
California condor	California
Tiger	Asia
American crocodile	United States and Central America
Galapagos tortoise	Galapagos Islands
Mountain gorilla	Africa
Socorro isopod	New Mexico
Green pitcher plant	United States
Crayfish	Arkansas
Nene goose	Hawaii
Hairy-nosed wombat	Australia

No Water Off a Duck's Back

Student Activity 20

Concept: Human actions, such as oil spills, can cause devastating environmental effects for wildlife.

Objectives: By conducting experiments, students will be able to identify ways oil spills can affect wildlife adversely and describe possible negative consequences to wildlife, people and the environment from human-caused pollutants.

Subjects: Biology, environmental science

Skills: Lab preparation, math calculations, data analysis, drawing, estimation, graphing, observation

Materials:

Cooking oil
Several shallow containers
Eye droppers
Hand lenses
Feathers (natural)
Liquid detergent
Hard-boiled eggs

Introduction:

The impact of environmental pollution often is difficult to see. A major oil spill, however, provides dramatic evidence of potential impact to wildlife. Examples include damage to feathers, killing of embryos when oil seeps into eggs, suffocation of fish when gills are clogged, and death to marine and terrestrial animals that ingest food and water contaminated by oil.

People are involved in efforts to prevent oil spills and their consequences. They also are involved in efforts to "clean up" after such spills take place. Such actions are not always successful, and sometimes they have unfortunate consequences as well. For example, the process of using detergents to clean oil from the feathers of birds caught in spills may also damage the bird's feather structure and arrangement and thus the bird's waterproofing. Birds may also be more susceptible to disease during this time of stress and may be weakened to the extent that it is more difficult for them to secure necessary food and water. Obviously, food and water sources may also be affected in quality.

Oil spills are just one example of pollution that can have adverse short- and long-term effects on wildlife, people and the environment. Students will examine some of the possible consequences for wildlife of human-caused pollution.

Procedure:

Divide the class into groups of three or four. Each group needs a shallow pan partially filled with water. Have students complete the following instructions:

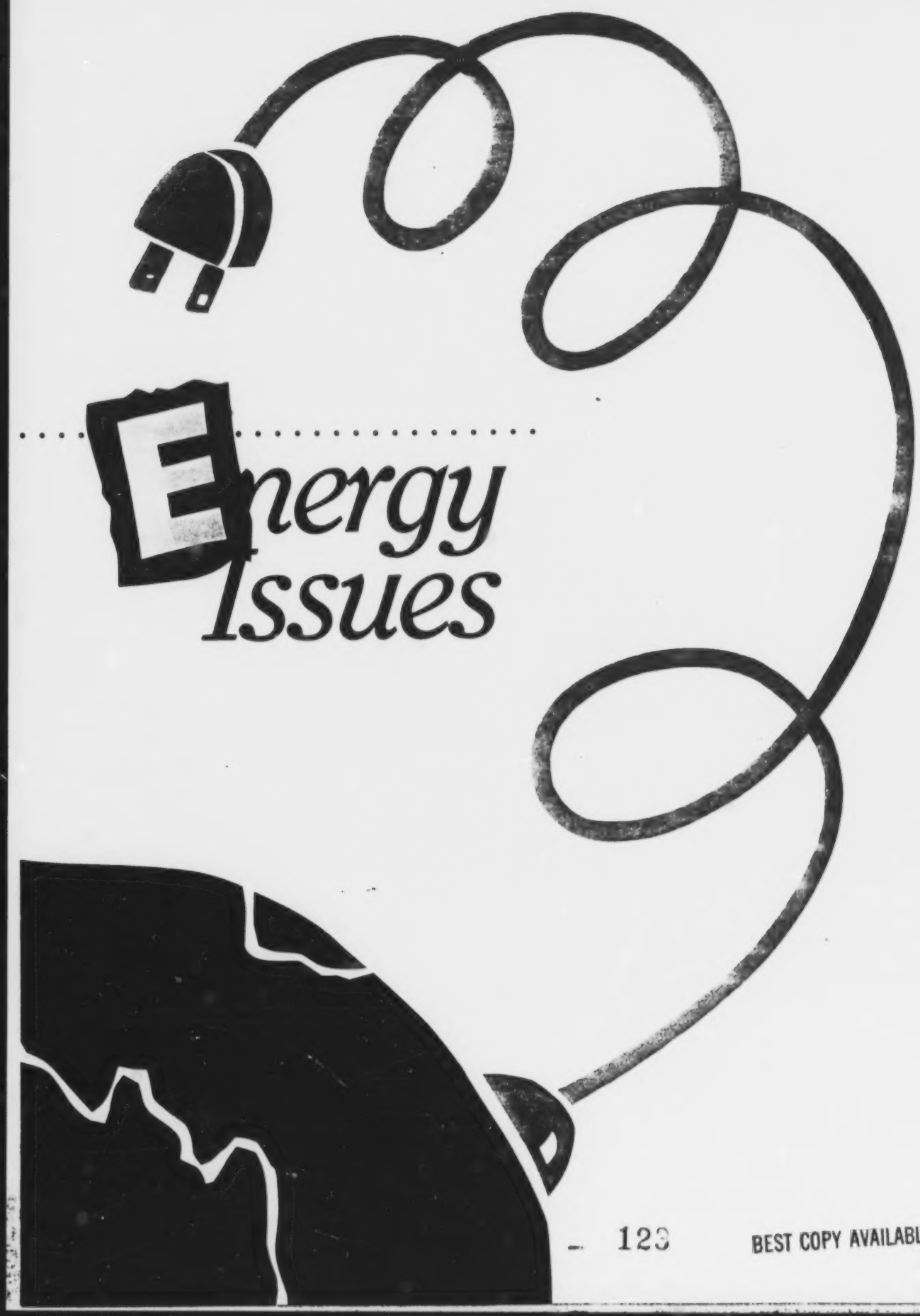
1. Add a known amount of oil, one drop to one dropper-full, depending on the size of the container. Observe the interaction of oil and water. Measure the area covered by the oil. Using this information, have students estimate the area that might be affected by an oil spill involving:
   a) A tanker truck holding 8,000 gallons of oil
   b) A ship holding 300,000 gallons of oil
   c) A supertanker holding 83,000,000 gallons of oil.

   Discuss and compare estimates with other groups. Graph estimates and compute average figures.
2. Put enough oil in a small container to submerge three hard-boiled eggs. Add the eggs. Put the eggs under a good light and watch closely. Remove one egg after five minutes and examine it—before, during, and after pulling off the shell. Try to remove the excess oil from the outside before attempting to peel the egg. Remove the second egg after 15 minutes and the third egg after 30 minutes, repeating the procedure, examining each carefully. Discuss observations. What effect could oil have on the eggs of birds nesting near the water?
3. Examine a feather with a hand lens. Sketch what you see. Dip the feather in water for one or two minutes, and examine again with a hand lens. Sketch and compare to the original observations. Place the feather in oil for one or two minutes, and then examine with a hand lens, sketch and compare with other sketches. Then dip the feather in water with detergent in it, rinse in clean water and examine again. Discuss changes in the feather after exposure to oil and then to detergents. What effect could these changes have on normal bird activity?
4. Discuss other possible effects on birds from an oil spill. Discuss possible impact on other wildlife species, on humans, and on the environment. Do we have to choose between oil and birds, as well as other wildlife? What are some alternatives? What are other examples of human-caused pollutants that can have negative consequences for wildlife, people and the environment? What is being done or can be done about these as well?

Follow-up Activity:

An extension of the activity might include using a variety of oils (cooking oil, motor oil, crude oil) to compare effects on feathers and eggs. Food coloring can be added to clear oils to facilitate observation of effects. Other pollutants can be used to see what, if any, effects they have on eggs and feathers. Exercise caution, however; do not use any unusually dangerous substances.

Adapted with permission from Project WILD. The original activity appears in Project WILD's Secondary Activity Guide, *Western Regional Environmental Council, copyright 1983, 1985, 1987.*



Energy Issues

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Energy Futures

Student Reading

When it comes to oil, the world's people seem to have an unquenchable thirst. Wasteful habits coupled with population growth fuel the demand for increased energy production. In 1989, the World Energy Conference projected that by 2020 the world would be using 75 percent more energy, most of which is likely to be supplied by coal, oil and nuclear power. Finite resources and environmental concerns may necessitate changes in energy use over the next 50 years.

Fossil Foolish

Fossil fuels today provide 78 percent of our energy. Oil provides 33 percent, coal 27 percent, and natural gas 18 percent. The future of fossil fuel consumption is unknown, although many predict that the demand will continue to increase. U.S. oil consumption is projected to increase from 17 million barrels per day in 1990 to 23 million barrels in 2010 and 26 million by the year 2030. Energy demand in most developing nations is expected to grow even faster. Recent U.S. Department of Energy studies predict a near tripling of oil consumption, and a quintupling (five times) of total energy consumption by the year 2050.

Although demand for fossil fuels continues to increase, the world's supply is far from limitless. According to the World Resources Institute, the estimates of oil yet to be recovered range from 300 billion to 1,100 billion barrels. Even with these projected additions, and an assumed constant oil consumption, the world will deplete half of the recoverable oil supply sometime between 1997 and 2017. The projections for natural gas do not fare much better, with a predicted decline beginning in 2015.

Driving Up the Stakes

One of the major consumers of fossil fuels is the automobile. In the United States, it has become a prized possession. There is one car for every two people and close to four million miles of public roads. With the increase in population comes an increase in the number of vehicles on the road. Urban planners respond by building more roads and expanding the existing roads—a temporary solution for congestion. According to the Federal Highway Administration, congestion will likely increase by more than 400 percent over the next 20 years on the nation's freeways and by 200 percent on other roads.

American transportation habits differ greatly from those in other industrialized countries. In many major U.S. cities, such as Denver, Houston, and Los Angeles, about 90 percent of workers commute by car. In European cities, about 40 percent commute by car, 37 percent use public transit, and the rest walk or bicycle. Only 15 percent of the population in industrialized Asian cities, such as Tokyo, drive to work by car. Such habits help to illustrate why the United States, with five percent of the world's population, consumes 28 percent of the world's energy.

Increased oil usage has led the United States to become dependent on foreign sources of oil. Imports have risen to 35 percent of the total U.S. supply and may go as high as 60 percent by the year 2000. This dependence on oil has proven to be a political and economic liability, as well as a threat to the global environment. Gasoline used in automobiles gives off 550 million tons of carbon into the atmosphere each year—a full ten percent of total emissions from all fossil fuels. These emissions contribute significantly to global warming and air pollution. Projections show these emissions increasing by 75 percent by 2010 in the United States as more people put more cars on the road.

Energy Alternatives

Although fossil fuels are the predominant energy sources in the industrialized world, they are not the only game in town. Research has been continuing since the early 1970s to develop and improve alternative sources of energy. Environmental concern and finite resources require that we switch to cleaner, more efficient energy alternatives. Both nuclear power and renewable energy sources have been examined as possibilities to replace fossil fuels. Increased use of nuclear energy and renewable resources during the past 15 years has already displaced 298 million and 192 million tons of carbon emissions, respectively.

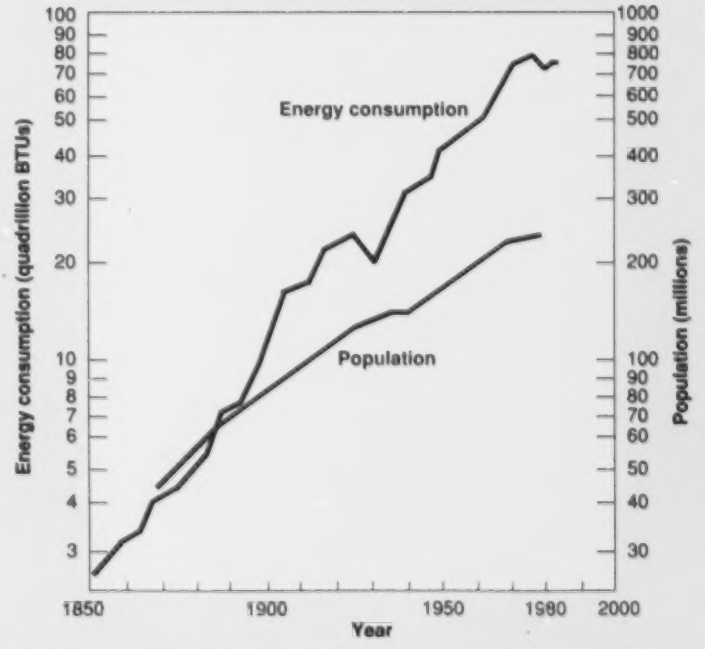
Nukes or No Nukes

In the years following World War II, the nuclear knowledge that led to the production of atomic weapons was redeployed for peaceful energy purposes. Nuclear fission emerged as a viable energy source, but not without risks. Dangers such as radiation poisoning, meltdown risks and unsafe disposal of nuclear wastes posed threats to the future of nuclear energy.

After 40 years of significant technological effort to support nuclear development, nuclear energy has become widely used. Approximately 30 governments produce energy from nuclear generators, accounting for 15 percent of all electricity used globally. Nuclear energy does not contribute to air pollution or global warming.

Although nuclear energy is now used widely throughout industrialized countries, its future is still suspect. Several nuclear power plant failures have brought to the public eye the potential risks of this energy source. Controversy has developed concerning the elimination of the hazardous waste as well as the safety and location of the reactor sites. Extensive research is being done to address the safety of nuclear power, but it is unclear whether any of these problems can be resolved in time to make nuclear fission a major option for the foreseeable future.

Comparison of Energy Consumption and Population Growth in the United States since the Mid-19th Century.



These data clearly indicate that per capita consumption increased considerably from the turn of this century until recently. Note that the vertical scales are logarithmic.

Reprinted with permission from Prentice Hall, as printed in *Environmental Science* by Charles E. Kupchella and Margaret C. Hyland, 1989.

Earth, Wind and Solar Fire

Many believe that clean, renewable fuels—solar, wind, hydroelectric and geothermal—should play a significant role in meeting future energy needs. Renewable resources are mostly still in the preliminary stages of development, but they offer the world potentially large primary energy sources, sustainable and available to every nation in one form or another.

Renewable energy already fills eight percent of U.S. energy needs. Many renewable energy sources have comparable advantages. They do not, for example, have the environmental drawbacks of synthetic fuels or the safety hazards of nuclear power.

Of all renewable sources, solar energy is likely to be the cornerstone of a future sustainable energy system. Sunshine is available in great quantity and is more

widely distributed than any other source. A few decades from now, societies may use the sun to heat most of their water, and new buildings may take advantage of natural heating and cooling to cut energy use by more than 80 percent. Wind power, a form of solar energy, also has great potential to provide electricity in numerous countries. Electricity is generated by propeller-driven mechanical turbines perched on strategically located towers.

Hydropower (water power) supplies nearly half of the world's electricity. Although there is still growth potential for this energy resource, environmental constraints may limit development. Risks such as land flooding, siltation, human displacement and wildlife endangerment surround the building of dams and reservoirs for the harnessing of hydropower. Geothermal energy, the latent heat from the Earth's core, can provide electricity when there is no sun or wind. Although geothermal resources are localized, they can provide energy to a number of areas along fault lines. With a continued substantial and sustained commitment to further research and development, the potential of these renewable energy sources can be realized.

Planning for Our Energy Future

We face difficult energy and economic choices in the years ahead. It is apparent that the supply of fossil fuels will not be sufficient to keep up with increased consumption, spurred on by population growth. In addition, continued expansion of fossil fuel use poses dire threats to the biosphere.

There is no time to waste in planning for a sustainable energy future, one that will ensure economic security as well as ecological preservation. Efforts on the international, federal, state and individual levels could produce solutions to the energy dilemma while at the same time making positive steps toward taking care of the planet. Individuals can alleviate the ill effects of fossil fuel combustion by conserving energy whenever possible. As a nation, we must commit ourselves to the research, development and implementation of cleaner, more efficient energy alternatives. But ensuring the safety of our planet will require global collaboration on sustainable energy policies, as well as reducing population growth.

Illustration by Sean Kelly

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Are People the Problem?

Student Activity 21

Concept: In order to determine whether a region is "overpopulated," students must consider consumption levels of resources and energy in addition to numbers of people.

Objective: Through data calculations and discussion questions, students will examine the relationship between population and energy consumption.

Subjects: Social studies, math, environmental science

Skills: Math calculations, data interpretation

Materials:

Copies of Student Worksheet 1 and Student Worksheet 2 for each student

Introduction:

When studying population pressures, it is important to consider consumption levels and their environmental impact. In this activity, students inquire into the relationships between numbers of people and energy consumption. After this examination, students are asked to consider the statement: *The United States is the most overpopulated country in the world today.*

Procedure:

1. Hand out Student Worksheet 1 to the students. Before beginning the activity, have students suggest some of the ways we use energy in this country. What aspects of our lives depend on energy being available? Have students list them.
2. Have students complete Student Worksheet 1 and the first part of Student Worksheet 2 either individually, in pairs, or as an entire class. Tell students to leave the third column of the chart in Student Worksheet 1 blank for now.
3. Discuss some of the students' answers to the questions in Student Worksheet 2. Tell the class they will test these answers by calculating the per capita energy consumption of the world.
4. Have students follow the directions on Student Worksheet 2. Then have a general discussion or have students write their responses to this statement: *The United States is the most overpopulated country in the world today.*

Follow-up Activity:

After determining the extent of energy consumption in the United States and the increase in energy consumption worldwide, students should now examine the environmental impact of increased energy use. Lead a discussion on the detrimental effects of increased fossil fuel use. How can less developed countries get ahead if they do not adopt the energy use habits of industrialized countries?

Adapted with permission from the University of Denver Center for Teaching International Relations. The original activity appears in Teaching About Population Issues, *by George Otero, Jr. and Richard Schweissing, Center for Teaching International Relations, University of Denver, CO, 1977.*

Suggested Answers to Student Worksheet 1

Energy Consumption	Population	Per Capita Energy Use (gigajoules)
North America, 26%	Asia, 58.9%	North America, 263.8 gj.
U.S.S.R., 25%	Africa, 12.6%	U.S.S.R., 178.3 gj.
Asia, 22%	Latin America, 8.4%	Oceania, 138.1 gj.
Western Europe, 18%	U.S.S.R., 7.3%	Western Europe, 131.1 gj.
Latin America, 5%	Western Europe, 7.1%	Latin America, 35.0 gj.
Africa, 3%	North America, 5.2%	Asia, 20.2 gj.
Oceania, 1%	Oceania, 0.5%	Africa, 10.8 gj.

Suggested Answers to Student Worksheet 2

1. a. 26% b. 22%
2. Answers may vary, but remember: a decrease in the *population* might help decrease energy consumption, but a decrease in the *growth rate* would not, unless it decreases to a negative rate.
3. Answers may vary. However, a decrease in population growth does not *automatically* create an increase in energy consumption.
4. Some of the many possible answers include: increased air pollution, increased climate change, more ozone layer depletion, shortage of fuels and more political conflicts.
5. The data suggest that factors such as energy consumption should also be considered when discussing the problem of overpopulation.

Are People the Problem?

Student Worksheet 1

1. Suppose we start reducing population growth rates tomorrow (by decreasing birth rates, etc.). Will this solve the problem of overpopulation?

2. Do countries with the smallest population size have the smallest population problem?

Energy has been a vital prerequisite for development in technology, science, medicine, etc. It is an important factor in the world today. By looking at its relationship to population size, we can shed some light on the above questions.

Look at these figures for the seven basic world areas.

AREA	ENERGY CONSUMED[1] (in petajoules*)	%	POPULATION[2] (in millions)	%
North America	73,587	26	280	5.2
Latin America	15,803	5	451	8.4
Western Europe	49,718	18	379	7.1
Eastern Europe and U.S.S.R.	69,368	25	389	7.3
Asia	63,353	22	3,155	58.9
Africa	7,353	3	677	12.6
Oceania	3,730	1	27	0.5
Total	282,912	100%	5,358	100%

* One petajoule is the same as 163,400 "U.N. standard" barrels of oil.

3. What do the data tell us? On the chart below list the world areas in decreasing order of energy consumption and then population size. Indicate the percentage after each. Leave the category "Per Capita Energy Use" blank for now.

	ENERGY CONSUMPTION	POPULATION	PER CAPITA ENERGY USE
(highest) 1.	%	%	
2.	%	%	
3.	%	%	
4.	%	%	
5.	%	%	
6.	%	%	
(lowest) 7.	%	%	

[1]*Data: World Resources Institute.* World Resources 1990-91, *New York: Oxford University Press. 1990.*

[2]*Data: Population Reference Bureau.* 1991 World Population Data Sheet.

Are People the Problem?

Student Worksheet 2

Part One:

1. 5.2% of the world's population consumes_____% of the world's energy while...

   58.9% of the world's population consumes_____% of the world's energy.

   What might account for this?

2. In your opinion, would a decrease in the U.S. population growth rate decrease its national energy consumption?

3. In your opinion, would a decrease in the population growth of Asia automatically increase energy consumption in Asia?

4. If all world areas eventually reach an energy consumption level comparable to that of North America, what problems might result?

5. How does the information presented here suggest that the problem of overpopulation involves more than a simple increase in numbers?

Part Two:

1. Now, turn back to Student Worksheet 1 and calculate the energy use per person and list the areas in descending order. (Note: You should convert your answers to gigajoules; 1 petajoule = 1,000,000 gigajoules.)

2. Do you still feel the same about your answers to the first two questions on Student Worksheet 1?

3. Considering what you have studied, respond to this statement: *The United States is the most overpopulated country in the world today.*

Getting Around

Student Activity 22

Concept: Transportation habits in the United States contribute greatly to the nation's dependency on fossil fuels. These habits need to be evaluated as we seek solutions to growing transportation problems.

Objectives: Students conduct a survey in their community on transportation habits. They can then tally and publicize the results and, possibly, recommend ways of managing transportation in your local area.

Subjects: Environmental science, social studies, family life

Skills: Developing and administering a survey, tabulating and interpreting results, evaluation

Introduction:

North Americans have a long-standing love affair with their cars. As the U.S. population increases, so do the number of cars on the road. There are more cars per person in the United States than in any other country—about one car for every two persons. This increase in the number of automobiles on the road contributes to traffic congestion and is the "driving" force behind many of our most pressing environmental concerns. Motor vehicles are major contributors to air pollution, ozone depletion, global warming, acid rain and the loss of scenic beauty as roads and parking lots pave over the American landscape.

Procedure:

1. In order to assess transportation habits in your local area, students will develop a survey to conduct in the community. As a class, have students devise questions that should be included on the survey. Below are some suggested questions:
   a. Do you drive a car?
   b. If so, what size car do you drive? (full-size, mid-size, compact, sub-compact, truck, van)
   c. How many miles do you put on your car each week?
   d. How many cars are owned by your household?
   e. Do you use your car to commute to school or work?
   f. If you do use a car to commute, what are the benefits over mass transit or other alternatives? What are the drawbacks?
   g. Do you carpool? If so, how many people are in your carpool?
   h. Do you usually drive the speed limit? Over? Under?
   i. If you do not use a car for commuting, how do you travel?
   j. Would you characterize traffic in your area as congested?
   k. Do you think the area needs more roads and highways?
   l. Do you feel that your area's public transit system is adequate for your needs?
   m. In what ways could it be better? (You may wish to throw in at least one question which requires a comment other than "yes" or "no.")
2. Have students determine whether they wish to do a demographic breakdown of their data. If so, they should add spaces for survey takers to check off factors such as their age and gender.
3. Once the content of the survey is determined, a representative from the class should type it up, leaving spaces for answers. Enough copies of the survey should be made so that each student has at least ten surveys to administer.
4. Conducting the survey may be done in a variety of ways. Since students wish to get a diverse sample from the community at large, it may be easiest for them to go to a busy area, such as a shopping mall or outside of a grocery store or subway station. Students can either seek permission to set up a table for people to stop and take the survey or they can walk around with a clipboard and ask questions of interested passers-by. Another option would be to go door-to-door in their neighborhoods. Respondents should be assured that their answers will be kept completely anonymous.
5. Each student should be responsible for tallying his or her own results. These results can then be compiled by one or two students in the class.
6. What do these results say about transportation habits in your community? Have students draw basic conclusions from the survey results. Consider having these results published in the school and/or local community newspaper.

Follow-up Activity:

Students can formulate recommendations for managing the community's transportation problems. They can explore the advantages and disadvantages of implementing various options, such as creating or widening roads, building a mass transit system, encouraging carpooling, limiting growth, etc. This activity need not end in the classroom. Students can voice their ideas at city council meetings or through letters to the editor of the area newspaper.

An Energizing Policy

Student Activity 23

Concept: To meet the energy needs of the U.S. population without relying on foreign oil or further endangering the environment, the U.S. government needs to formulate a sustainable energy policy.

Objective: Acting as presidential advisors on energy policy, students formulate a proposal for U.S. energy use, addressing energy sources and consumption levels, as well as economic and environmental costs and benefits.

Subjects: Social studies, environmental science, general science, economics, language arts

Skills: Critical thinking, research, writing, decision making, persuasion

Materials:

Copies of Student Worksheet
Research materials from various energy associations (see list included in this activity), public interest groups and library resources

Introduction:

In 1991, oil accounted for about one-half of the energy consumed in the United States. Although the United States comprises five percent of the world's population, it consumes 28 percent of the world's oil supply. Since 1985, U.S. oil imports have increased while domestic production has decreased. Oil prices dropped sharply in the mid-1980s, encouraging increased oil consumption. The sharp drop in world oil prices also discouraged investment in U.S. oil exploration, conservation, development of alternative energy sources, and energy-efficient technologies. The 1991 Persian Gulf War persuaded many Americans that it would be advantageous to implement an energy strategy that lessens U.S. dependence on foreign oil.

Procedure:

1. Distribute copies of the Student Worksheet.
2. Using the list of energy organizations on the page following the Student Worksheets, you may wish to write for literature ahead of time, so that students have research materials readily available. If you prefer to have students request research materials, assign them this task about a month prior to their energy policy due date.
3. Allow students creativity with this project and encourage them to go beyond the partial list of energy policy options listed on the Student Worksheet. You may wish to suggest an appropriate length for the completed proposals.
4. If you choose to grade this activity, look for demonstrated research, clarity of thought, persuasive argumentation and critical thinking skills.

Follow-up Activity:

This activity does not have to end when students turn in their proposed energy policies. You may wish to have the students consider each other's proposals (perhaps anonymously) and try to come up with a group proposal. This will involve a great deal of debate, negotiation, consensus-building and revision. This is similar to the process which members of Congress undergo in drafting legislation. Once the class finalizes its proposed energy policy, have them send it off to the President and/or their members of Congress.

Office of the President
The White House
1600 Pennsylvania Avenue, NW
Washington, DC 20500

Representative _____
The U.S. House of Representatives
Washington, DC 20515

Senator _____
The U.S. Senate
Washington, DC 20510

An Energizing Policy

Student Worksheet

You have been appointed the U.S. President's chief advisor on energy issues. Your assignment is to design an energy policy for the United States. When formulating this policy, you will need to weigh the advantages and disadvantages of a number of energy sources. Below is a partial list of policy options to consider. When considering these options and others, keep in mind the economic and environmental costs and benefits of each alternative. What groups or individuals would be most affected by your recommendations? To help you make these difficult decisions, try to collect information on various energy sources. The list of organizations and resources on the next page may help you in your research.

Your proposal may include several recommendations. Be as specific as possible. For instance, if you recommend increased energy conservation measures, be precise about what form these measures would take and how they should be implemented. For each recommendation, give a full explanation as to why this plan would best benefit the United States.

Possible Energy Policy Options:

1. Continue to rely heavily on foreign oil reserves.
2. Rely on foreign reserves of natural gas.
3. Open the Arctic National Wildlife Refuge (ANWR) to oil drilling.
4. Accelerate nuclear power licensing.
5. Encourage the use of one or more of the following renewable energy resources and specify ways to promote these options:
   - solar;
   - geothermal (heat from the earth's inner core);
   - wind;
   - hydropower (water);
   - biomass (burning wood, dung, decaying plants, etc.).
6. Raise energy efficiency in businesses and/or homes.
7. Increase fuel efficiency in automobiles.
8. Reduce speed limits and enforce them.
9. Tax oil imports and/or gasoline.
10. Use non-gasoline fuels in automobiles or encourage the greater development and use of electric automobiles.
11. Encourage bicycling for short trips.
12. Provide incentives for the development of mass transit systems in congested areas.
13. Implement mandatory energy conservation measures for individuals, households and/or businesses.
14. Stabilize U.S. population to curtail a further increase on energy demands.

SUGGESTED RESOURCES ON ENERGY INFORMATION

Trade and Professional Associations

American Gas Association
1515 Wilson Boulevard
Arlington, VA 22209
703/841-8400

American Nuclear Energy Council
410 First Street, SE
Washington, DC 20003
202/484-2670

American Ocean Energy
Industries Association
777 North Capitol Street, NE, #805
Washington, DC 20002
202/408-0660

American Petroleum Institute
1220 L Street, NW
Washington, DC 20036
202/682-8000

American Public Gas Association
11094-D Lee Highway, #102
Fairfax, VA 22030
703/352-3890

American Wind Energy Association
777 North Capitol Street, NE, #805
Washington, DC 20002
202/408-8536

Edison Electric Institute
701 Pennsylvania Avenue, NW
Washington, DC 20004
202/508-5000

Electric Power Research Institute
1019 19th Street, NW, #1000
Washington, DC 20036
202/872-9222

National Coal Association
1130 17th Street, NW
Washington, DC 20036
202/463-2625

National Petroleum Council
1625 K Street, NW, #600
Washington, DC 20006
202/393-6100

National Wood Energy Association
777 North Capitol Street, NE, #805
Washington, DC 20002
202/408-0664

Natural Gas Association of America
555 13th Street, NW, #300
Washington, DC 20004
202/626-3200

Renewable Energy Institute
1001 Connecticut Avenue, NW
Washington, DC 20036
202/857-1660

Solar Energy Industries Association
777 North Capitol Street, NE, #805
Washington, DC 20002
202/408-0660

Interest Groups

Americans for Energy Independence
1629 K Street, NW, #602
Washington, DC 20005
202/466-2105

Americans for Nuclear Energy
2525 Wilson Boulevard
Arlington, VA 22201
703/528-4430

Consumer Energy Council of America
Research Foundation
2000 L Street, NW, #802
Washington, DC 20036
202/659-0404

Energy Conservation Coalition
1525 New Hampshire Avenue, NW
Washington, DC 20036
202/745-4874

Nuclear Control Institute
1000 Connecticut Avenue, NW, #704
Washington, DC 20036
202/822-8444

Nuclear Information and Resource Service
1424 16th Street, NW, #601
Washington, DC 20036
202/328-0002

Public Citizen
2000 P Street, NW, #700
Washington, DC 20036
202/833-3000

Union of Concerned Scientists
1616 P Street, NW
Washington, DC 20036
202/332-0900

U.S. Council for Energy Awareness
1776 Eye Street, NW, #400
Washington, DC 20036
202/293-0770

World Resources Institute
1709 New York Avenue, NW
Washington, DC 20006-3708
202/638-6300

Government Agency

U.S. Department of Energy
Public Information Office
1000 Independence Avenue, SW
Washington, DC 20585
202/586-5000

Rich and Poor

The Rising Tide of Poverty

Student Reading

We live in an economically divided world. One-fifth of the world's population enjoys relative wealth, while the other four-fifths have barely the means of survival. As the wealthy industrialized countries speak of economic progress, the ranks of the poor in less developed countries continue to grow. This gross disparity of wealth and spread of abject poverty threaten the future quality of life for all of Earth's inhabitants.

For the majority of the world's people, poverty is far more than an economic condition. Poverty's effects extend into all aspects of a person's life, such as susceptibility to disease, limited access to most types of services and information, subordination to higher social and economic classes, and complete insecurity in the face of changing circumstances.

There are more hungry people in the world today than ever before in history, and the numbers are growing. The number of people living in slums and shantytowns is also increasing. A growing number lack access to clean water and sanitation, and hence fall victim to diseases that arise from this absence. There is some progress noticeable in places. But on the whole, poverty continues and the numbers multiply.

Who Are the Poor?

Most of the world's more than one billion poor live in Africa, Asia and Latin America. The poor are overwhelmingly illiterate, and therefore lack access to information and ideas that could help them escape poverty. Numerically, the group most plagued by poverty is children. People with lower incomes tend to have larger family sizes. Fully two-thirds of the world's poor are under age 15, and their prospects are bleak. Chronic persistent hunger condemns many to a life of ill health, stunted growth and mental impairment. Lacking sufficient nourishment and clean water, a third of these youngsters die before their fifth birthday.

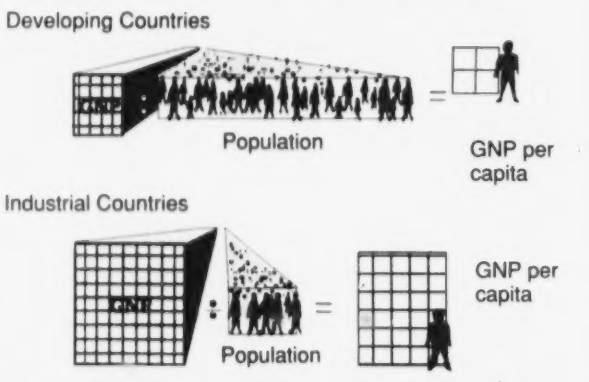
The poor earn little and own even less. With most of the land owned by a wealthy few, the majority of the world's population is landless. Population growth divides family subsistence farms into smaller and smaller plots, until they no longer provide subsistence. Then, typically, poor people are forced to work as dispossessed laborers for others, unable to achieve economic prosperity. Rapid growth in numbers also perpetuates poverty by lowering wages as the poor compete for scarce work.

What A Difference!

The disparities in living standards between the world's rich and poor verge on the grotesque. In 1989, the world had 157 billionaires, perhaps two million millionaires, and 100 million homeless. Wealthy nations have almost tripled their per capita income since mid-century, but that figure in the poorest countries has remained basically constant. Today, average annual household income ranges anywhere from $400 in parts of Africa and Asia to over $20,000 in the United States. Even these figures do not account for the gross disparity of income distribution within each country. A full 60 to 70 percent of people in most countries earn less than their nation's average income.

Alan Durning, researcher for the Worldwatch Institute, illustrates the astounding differences in lifestyle between rich and poor:

GNP, Population, and GNP per Capita



GNP per capita is low in developing countries. They produce only one-fifth as many goods and services as industrial countries but have *five times as many people*.

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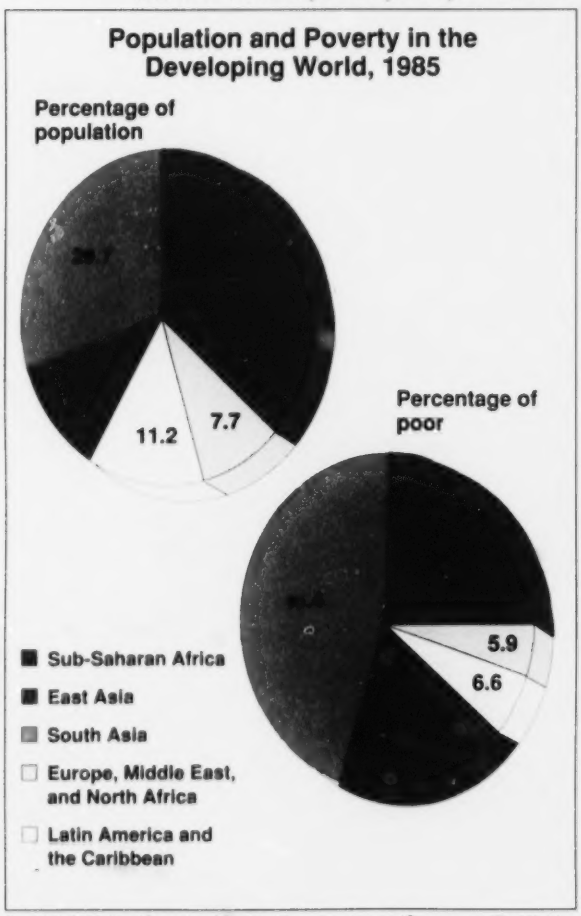
"Americans spend five billion dollars each year on special diets to lower their calorie intake, while 400 million people around the world are so undernourished their bodies and minds are deteriorating. As water from a single spring in France is bottled and shipped to the prosperous around the globe, nearly two

billion people drink and bathe in water contaminated with deadly parasites and pathogens."

In recent years, the term "developing country" has become a misnomer: many countries are not so much developing as they are disintegrating. During the 1980s, when industrialized countries experienced an economic resurgence, less developed countries in Africa and Asia endured economic decline characterized by a soaring population, famine and ecological disaster.

No Place Like Home

Although most of the world's poor are residents of less developed countries, people in even the world's richest countries can fall victim to vicious cycles of poverty. Nowhere is this more evident than in the United States. Homelessness is a growing trend in the world's wealthiest country. While millionaires sip champagne in luxurious New York City penthouses, thousands of people sleep on the dirty sidewalk below, begging as a means of daily survival. Estimates of the nation's homeless in 1991 ranged anywhere from 250,000 to over one million.



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The housing situation in less developed countries is far more bleak. Low-income housing is almost non-existent in most developing-world cities. Generally, those with low incomes either rent rooms, live on the streets or construct cardboard shacks in illegal settlements. These settlements, called shantytowns, often surround cities. Bereft of indoor plumbing, shantytown dwellers use open latrines which produce airborne poisons and contaminate the water supply. The locations of shantytowns, often near garbage dumps and hazardous waste sites, further endanger their residents. Disease and death are everyday occurrences for millions of urban poor.

Impoverish the Earth

Continued poverty places much of the world's people on a collision course with environmental disaster. Most of the world's countries depend on the export of agricultural products for their livelihood. But agricultural expansion can often cause ecological stress. Wealthy landowners, cultivating more and more acres for commercial crops, continue to push subsistence farmers onto poor land. Farmers, pushed onto marginal land by population growth and inequitable land distribution, attempt to increase their cropland by cutting forests and cultivating land on steep slopes. Both of these practices increase the incidence of soil erosion, resulting in droughts and floods.

Such natural disasters have occurred in recent years with droughts in Africa, India and Latin America, and floods throughout Asia, parts of Africa and the Andean region of Latin America. The poor, living on vulnerable hillsides and along unprotected shores, are overwhelmingly the victims of these disasters.

Environmental degradation, as it relates to poverty, is further compounded by explosive population growth in much of the developing world. In rural areas, couples often desire many children, in order to help work the land and

Illustration by Ben Mayhan, 1990

provide for the family. But overworked land fails to provide for the growing number of hungry. Population growth succeeds only in bringing about rapid depletion of natural resources, increased poverty, hunger and environmental damage.

Reversing the Trend

Although the challenges to breaking the cycle of poverty are monumental, failure to launch an assault on poverty will guarantee the destruction of much of our shared biosphere. Assistance programs will need to be implemented at local, national and international levels.

Studies on every continent show that as literacy rates rise, especially those of women, so do income levels, nutrition levels, and child survival rates. Population growth slows as men and women find economic opportunities in limiting family size. Education and sustainable development have grown in some areas as poor people have organized into grassroots groups to fight economic and environmental deterioration. Loan programs from local governments and international organizations have also triggered successes in advancing formal education, health and proper nutrition.

On a national level, land reforms and employment programs are required to provide the poor with economic opportunities and a means for working for environmental preservation. International reforms are equally as important, since poor countries often have no choice but to sacrifice the environment to pay off astronomical international debts. Clearly, eradicating poverty will require cooperation and humanitarian planning from every nation.

The Lion's Share

Student Activity 24

Concept: Just as family size and income determine lifestyle, a country's population size directly relates to its per capita Gross Domestic Product (GDP).

Objectives: Students examine how family size and income are related to the amount of money spent on necessities, goods and services.

Students examine how a country's population size is related to per capita GDP.

Subjects: Social studies, math, economics, family life

Skills: Data analysis, math calculations, research and preparation of a budget

Materials:

Copies of Student Worksheet

Introduction:

The relationships between income, consumption, family size and total population are complex. The following activity allows students to examine how family size and income are related to the amount of money each of us spends for food, shelter, transportation, and the many services and products that make our lives more comfortable. Students will be able to see how these relationships directly affect the way we live.

Procedure:

Distribute copies of the Student Worksheet. After students have had a chance to work through the questions, go over answers in class. The follow-up activity is best assigned for homework.

Note: Gross Domestic Product (GDP) is defined on Part 2 of the Student Worksheet. Students may be more familiar with the term GNP (Gross National Product), so you may want to explain to students that is virtually the same thing. The only difference is that GDP measures economic activity within a country's borders, while GNP also includes a country's economic activity occurring in other countries. Both figures provide a good insight into the economic "might" of a country.

Suggested Answers for Student Worksheet:

Part 1:

a. housing and utilities; yes; the low-income family

b. $2,772 on food per year; $5,112 on housing per year

c. $4,053 per person; $693 per person for food

d. $2,702 per person; $462 per person for food

Part 2:

a. The United States has the highest GDP; Kenya has the lowest. The countries should be ranked as follows:

1. United States
2. U.S.S.R.
3. France
4. China
5. India
6. Mexico
7. Indonesia
8. Saudi Arabia
9. Chile
10. Kenya

b. See the listing below for per capita GDP; no, the figures do not mean that each person receives this amount, since GDP involves more than wages paid and wealth is distributed unequally. However, GDP does tend to indicate the relative availability of goods and services in a particular country.

Country	Per Capita GDP	Ranking
United States	$20,708	1
China	$375	8
India	$282	10
Saudi Arabia	$5,777	4
Kenya	$297	9
U.S.S.R.	$9,343	3
France	$17,068	2
Chile	$1,942	6
Indonesia	$528	7
Mexico	$2,362	5

c. See listing above for ranking; India moved down the most, followed by China, while Saudi Arabia moved up the most. The change in ranking indicates that straight GDP figures do not necessarily indicate how wealthy the average person in the country is likely to be. The countries which moved down had large GDP's, but had to divide it among a very large number of people. The reverse is true for the countries which moved up in ranking.

Part 3:

a. India had a 37 percent increase; the United States had a 92 percent increase.

b. India's per capita GDP was $250 in 1980 and increased to $294 in 1989 (18 percent increase); U.S. per capita GDP was $11,784 in 1980 and increased to $21,150 in 1989 (79 percent increase). These figures show that when population growth is also considered, increases in GDP for the whole country can be misleading. Also, the disparity between India and the United States becomes more pronounced.

c. When a country's population is growing at a faster rate than the GDP, a substantial increase in GDP will not mean more money for most individuals in that country.

Follow-up Activity:

As these activities indicate, population growth and economic growth do not necessarily go hand in hand. Have students select three less developed countries to examine the correlation between population growth rate and per capita GDP. They should then compare this information with that of three developed countries. Almanacs and other library reference sources should be helpful in retrieving this information.

Adapted from Global 2000 Countdown Kit, *Zero Population Growth, Washington, DC, 1982.*

The Lion's Share

Student Worksheet

This activity is divided into four parts. In the first part, you will see how a middle-income and low-income family in the United States spend their salaries. You will then calculate how much money is available for each family member if family size increases. In the second part, you will work with a chart showing the Gross Domestic Product (GDP) of several countries. From this chart, you will calculate the individual and family "share" of the GDP for each country. In the third part, you will examine one example of how GDP and population size relate to each other. Finally, you will plan a hypothetical budget for yourself.

Part 1:

Look at the Monthly Budget chart below and compare how these two families spend their money. Answer the following questions:

a. What item takes the largest percentage of the family income in the low-income family? Is the same true for the middle-income family? Which family spends a larger percentage of its income on food?

b. The chart shows figures for one month. How much does a low-income family spend on food in a year? On housing?

c. What is the average amount of money available to each low-income family member in a year? How much does each member have for food in a year? (Assume that the money and food are divided equally among all family members even though children may actually consume less than adults.)

d. If the family grew by two more children and the income remained the same, what would be the average amount of money available for each family member in a year? How much would each member have for food?

Monthly Budget for a Family of 4 (in 1987 Dollars)

	Middle-Income*		Low-Income**	
	% Income	Amount	% Income	Amount
Food	13	$ 361	17	$ 231
Housing and Utilities[1]	26	$ 710	32	$ 426
Transportation[2]	18	$ 494	18	$ 243
Clothing	6	$ 153	6	$ 78
Health Care	4	$ 100	6	$ 88
Taxes, Pensions and Social Security	18	$ 480	7	$ 92
Other[3]	15	$ 410	14	$ 193
Total	100%	$2,708	100%	$1,351

* Based on annual household income before taxes of $33,276
** Based on annual household income before taxes of $11,954
[1] Includes shelter, fuel, utilities and public services, household operations, furnishings and housekeeping supplies
[2] Includes vehicle purchases, gasoline and motor oil, other vehicle expenses and public transportation
[3] Includes life insurance, entertainment, personal care, reading, education, tobacco and smoking supplies, alcoholic beverages, cash contributions and miscellaneous expenditures

Source: U.S. Bureau of Labor Statistics, Consumer Expenditure Survey: Integrated Survey Data 1984-87, Bulletin 2333.

Part 2:

Review the chart below. GDP stands for Gross Domestic Product, which is a measure of a country's goods and services (i.e., the wealth of the country).

a. Which country has the highest GDP? The lowest? Rank the countries by putting a number next to their GDPs (1 = highest, 10 = lowest).

b. Using the population figures on the chart, calculate the per capita GDP (i.e. each person's "share" of the GDP) for each country. Does this mean that each person in these countries receives the amount you calculated?

c. Now rank the countries according to the per capita GDP.
Which countries moved the most on the scale? What does their change in ranking indicate?

GDP AND POPULATION OF SELECTED COUNTRIES, 1989

Country	Gross Domestic Product	Population
United States	$5,156,440,000,000	249,000,000
People's Republic of China	$417,830,000,000	1,114,000,000
India	$235,220,000,000	833,000,000
Saudi Arabia	$80,890,000,000	80,890,000
Kenya	$7,130,000,000	24,000,000
U.S.S.R.	$2,700,000,000,000	289,000,000
France	$955,790,000,000	56,000,000
Chile	$25,250,000,000	13,000,000
Indonesia	$93,970,000,000	178,000,000
Mexico	$200,730,000,000	85,000,000

Source: World Bank, World Development Report 1991 *and U.S. Central Intelligence Agency,* The World Fact Book, *1990.*

Part 3:

Look at the chart below which contrasts India's GDP and population with the U.S. GDP and population.

a. Notice that the GDP has increased for both countries. What was the percentage of increase for each country from 1980 to 1989?

b. Calculate the per capita GDP by dividing the population into the GDP for both countries for each year.

c. Using this information, explain why a substantial increase in a country's GDP does not necessarily mean more money for most individuals living in that country.

INDIA

Year	GDP	Population
1980	$172,129,000,000	688,994,000
1989	$235,220,000,000	800,326,000

UNITED STATES

Year	GDP	Population
1980	$2,684,400,000,000	227,757,000
1989	$5,156,440,000,000	243,830,000

Source: The World Bank, World Tables 1991 *and* World Development Report 1991.

Part 4:

The first chart you analyzed shows how two typical American households spend their money. Imagine that you are setting up your own household and are preparing your budget. Will you be married? Having children? Going to college? Sharing an apartment with friends?

After you decide on your hypothetical situation, look in the classified ads of your newspaper to see how much monthly rent you would have to pay for your house or apartment. Use the grocery ads to calculate your food bill for a month. Check your household's present utility bills to estimate the costs you may anticipate. Look at car ads and estimate monthly car payments, insurance and gasoline, or calculate monthly bus or subway fare. Then add a figure for miscellaneous expenses such as medical bills, clothing, taxes, entertainment, etc. What is your monthly total?

As a last step, turn again to the newspaper and look in the employment section. Do any of the jobs for which you might be qualified provide enough money to meet your monthly bills?

As you do the above activity, divide expenditures into either necessities or luxuries. If your income were to be reduced, what items would you forego? Are they mostly items you listed as luxuries? Do you think people in countries with low GDP's spend the same percentage of their income for luxury items that you do?

Living on Less Than $400 a Year

Student Activity 25

Introduction:

To understand economic development, one must first have a picture of the problem with which it contends. The following exercise helps students conjure up a picture in their mind's eye of what "less developed" really means for the three billion human beings for whom it is not a statistic but an experience of daily life. The $400-a- year figure is based on per capita GNP in 1988 U.S. dollars.[1] The follow-up discussion focuses on ways we can work to lessen the gap between the developed and developing countries.

Procedure:

1. Copy the Suggested Reading and distribute it to the class. Make sure to leave plenty of time for the small group work so that the message does not seem overwhelmingly bleak and hopeless for the students.
2. As a class, create a list of the disadvantages of living in a less developed country. Then have students vote to determine the five biggest problems. Focus on these areas as you do the following problem solving. Remind students that good and bad are relative terms. For example, would they really miss *Nintendo*™ if no one in their village had it and they had never heard of it?
3. Have students break into five groups and assign one of the focus areas to each group. These groups should brainstorm to come up with as many solutions to their assigned problem as possible. A recorder from each group needs to fill out the Student Worksheet, which encourages students to think broadly when coming up with solutions.
4. Once groups have thought of a wide range of solutions, have students evaluate the options for effectiveness and feasibility. Students should write down obstacles to the solutions and ways to overcome these obstacles. For example, assigning a tutor to every child would definitely help solve the literacy problem, but it would be next to impossible to find that many tutors. Some ideas will need to be modified during this critical thinking process (e.g., perhaps the government could set up a program to match volunteers with illiterate community groups to help solve the problem).
5. After evaluating their options, groups should pick their one or two favorite ideas. Have a spokesperson from each group read the chosen solution(s) to the class.

Follow-up Activity:

Ask the class if all of these solutions were enacted over the next ten years, how the picture would differ from that given in the reading. What items would the "average family" get back? Which would still be missing? Are there any important areas on which the class forgot to focus?

[1] World Development Report 1990 *by the World Bank (Oxford: Oxford University Press, 1990), p. 178.*

Concept: Most of the world's people have a very different standard of living than those in North America.

Objective: By reading and discussing a passage which describes the transformation of an average North American's lifestyle to that of an average person in a less developed country, students gain an understanding of the disparity between the two regions. A solution-oriented follow-up activity encourages students to think about ways to change this inequality.

Subjects: Social studies, economics, language arts, family life

Skills: Brainstorming, cooperation, problem-solving, evaluation, critical thinking

Materials:

Copies of Suggested Reading and Student Worksheet

Living on Less Than $400 a Year

Suggested Reading

In order to understand the long road ahead of less developed countries, we must make a radical adjustment of our picture of the world. It is not easy to make this mental jump. But let us attempt it by imagining how a typical American family, living in a small suburban house with an income of $21,000 (the U.S. per capita GNP*), could be transformed into an equally typical family of the less developed world. We will use Africa as a model, where the majority of the countries have a per capita GNP under $400.

We begin by shutting off the electricity and removing everything that uses it—lamps, appliances, television, heat and air conditioning.

We take out the beds, chairs, rugs and curtains. We are left with only a few old blankets, a kitchen table and a wooden chair. Along with the dressers go the clothes. Each family member may keep in his "wardrobe" his oldest suit or dress, and a shirt or blouse.

Next we shut off running water. If the family is lucky, there will be a latrine and pump down the road to share with the community.

We move to the kitchen. The appliances have already been taken out, so turn to the cupboards. A box of matches, a small bag of flour, some sugar and salt may stay. A few moldy potatoes, already in the garbage can, must be rescued, for they will provide much of tonight's meal. We will leave a handful of onions, and a dish of dried beans. All the rest we take away: the fresh vegetables, the canned goods, the meat, the milk.

Now that the house is stripped, we take it away. The family moves to the tool shed. It is crowded, but at least they have shelter. Although the family is in a smaller space, their numbers have increased. Instead of being an average North American two-child family, they now have six children (the average in most of Africa). All other houses in the neighborhood have also been replaced with small structures, jammed together, full of people.

Communication must go next. No more newspapers, magazines, books—not that they are missed, since we must also take away the family's literacy. Instead, we will allow one radio in the shantytown.

Next, government services must go. No more postal carrier, no more fire fighter, no more garbage collector. There is a school, but it is three miles away and consists of two classrooms. They are not overcrowded since only half the children in the neighborhood, mainly boys, go to school.

There are no hospitals or doctors nearby. The nearest clinic is ten miles away and is staffed by a midwife. It can be reached by bicycle, provided that the family has a bicycle, which is unlikely. Or one can go by bus—there is usually room on top, if not inside.

Finally, money: we will allow our family a cash hoard of $10. Meanwhile, they must earn their keep. Since the children are not likely to be in school long, most of them will work beside their parents all day. As peasant cultivators with three acres to tend, they may raise the equivalent of $200 to $500 worth of crops a year. If they are tenant farmers, which is more than likely, a third or so of the crop will go to the landlord, and probably another ten percent to the local moneylender.

But there will be enough to eat, or almost. The average human body needs a daily input of 2,000 calories just to replenish the energy consumed by its living cells, and people in sub-Saharan Africa average 2,095 calories. Like any insufficiently fueled machinery, their bodies run down sooner; the life expectancy in Africa is 53 years.

This is life as lived by hundreds of millions of people. Of course it is just an impression—it is missing the many strong smells and sounds of streets overflowing with humanity. It is also missing the sense of familiarity these people have with their situation; what may seem shocking to us is routine for those who have never known anything else. But the impression gives life to the statistics by which underdevelopment is ordinarily measured. When we are told that half the world's population enjoys a standard of living of "less than $400 a year," this is what that figure means.

*Note: GNP refers to the Gross National Product, which is a way of measuring the economic value of a country's goods and services. Per capita means that the figure shows each person's "share of the wealth."

Updated and adapted with permission from Harper and Row Publishers, Inc. The original passage appears in The Great Ascent, *by Robert Heilbroner (Harper and Row Publishers, Inc., 1963), pp. 33-37.*

Living on Less Than $400 a Year

Student Worksheet

Names of people in group:

Problem to solve:

Things other countries, especially more developed countries, can do on an international level:

Things the government can do nationally:

Things that the community can do on a local level:

Things that a person or family can do individually:

Population and Economics

Economic Growing Pains

Student Reading

It is a commonly held belief, especially in the United States, that growth is always desirable. In fact, economic growth is as much a part of American history and culture as baseball and apple pie. For more than 300 years, Americans have aimed to conquer new frontiers, go for the gold, and keep up with the Joneses. The promise of continued economic growth has been a constant theme in advertising campaigns, selling everything from automobiles to political candidates. Now, in this age of global interdependence and environmental awareness, we may be "outgrowing" these long-held economic principles.

Much of our economic growth is dependent upon using the finite resources of the Earth. But if exponential growth of human populations and resource consumption continues, we will reach a point where the Earth can no longer sustain its inhabitants. Warning signs of the Earth's limitations are already apparent in the deterioration of our life-support systems: shrinking forests, expanding deserts, eroding croplands, thinning ozone layer, accumulating greenhouse gases, increasing wildlife extinction and biological damage from air pollution and acid rain.

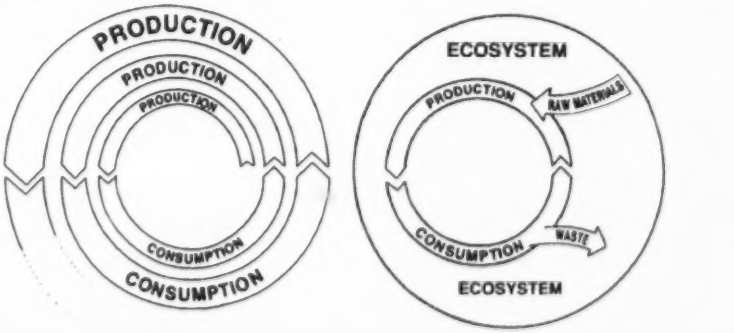
In recent years, the environmental impact of growing industrialization worldwide has raised questions about the limits of economic growth. Although many economists still encourage unrestricted resource consumption and land use, there is a growing movement of economists who advocate a more sustainable economic plan for our planet.

Herman Daly, senior economist at the World Bank, leads the pack of economists who feel the time has come to put an end to the phenomenon of "growthmania." Daly cautions that we should not confuse "growth" with "development." "To grow" means to increase in size by the accumulation of material. "To develop" means to improve in quality. A growing economy is getting bigger; a developing economy is getting better. An economy can therefore develop without growing, or grow without developing.

The Steady-State Economy

Daly proposes reordering our economic priorities to establish a "steady-state economy," whereby the economy develops qualitatively without growing quantitatively. This requires a change in some of our traditionally held economic principles. "Whenever you say there's an alternative to growth," says Daly, "all people can think of is non-growth and they begin to worry. If you stop growing in a growth economy, you're in trouble! It's like an airplane that's designed for forward motion. If it stops still in the air, it's going to crash. It just wasn't meant to do that. It doesn't mean there's no such thing as a helicopter, which can stay still in the air; but you can't do it with an airplane. So you've got to ask: How do you convert the growth airplane into a steady-state helicopter? What do you have to redesign?"

Unlike our present economy, the steady-state economy is characterized by a constant population of humans and a constant amount of available goods. The desired population and amount of goods should be maintained at levels that provide for a decent standard of living for present and future generations. In the interest of conserving resources and preserving our environment, Daly also stipulates that the rate of "throughput" (input and output) be reduced to the lowest feasible levels. For example, limiting our use of fossil fuels will, in turn, limit the production of gases contributing to air pollution, acid rain and global climate change. The availability of natural resources could be sustained if we live off the dividends, rather than dipping into our capital. In this scenario, the Earth's ecosystems could be



Standard Economics

Standard economics considers ever-growing cycles of production and consumption but does not consider the role of the supporting ecosystem. Such a view can encourage an economy which ultimately strains the surrounding environment.

Steady-State Economics

Steady-state economics considers cycles of production and consumption which take the surrounding ecosystem into account and tries to achieve a state of equilibrium with it.

maintained indefinitely and more people could enjoy a better quality of life.

Promoting Ethical Growth

As part of his steady-state economy, Daly does advocate one type of growth—moral growth. Growing morally, humans would evolve as a species that values the well-being of other humans, other species and the Earth's ecosystems, rather than the acquisition of wealth and material goods. This new economic morality would reject the assumption that an economy must be placed somewhere along the left-right political spectrum, and focus instead on a community orientation of the economy.

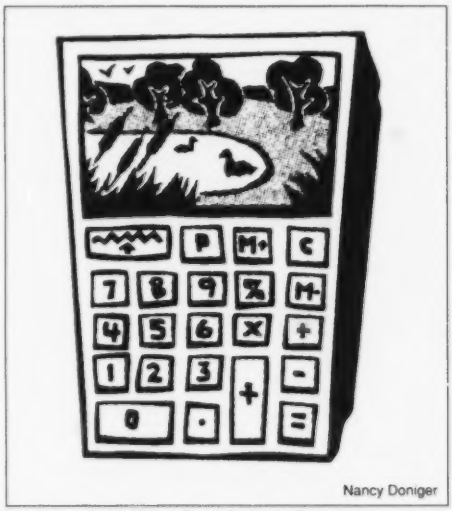
Ethical economics would also require that we not sacrifice the quality of life for future generations to pay for today's damaging, unsustainable habits. "The basic needs of the present should always dominate the basic needs of the future," writes Daly. "But the basic needs of the future should take precedence over the luxuries of the present."

Daly's plan for a moral economic system includes a more equitable distribution of wealth which improves global quality of life for all and is in keeping with a healthy market economy and political democracy. To insure this more equitable distribution, there would be minimum and maximum limits on income and wealth. Although this concept may seem contrary to the "American dream" of making millions, Daly notes that maximum limits on income and wealth were implicit in the philosophies of most of the prominent people who founded the United States of America.

Ecological Economics

"What is not ecological is not economic," reads a Czech Green Party slogan. This sentiment is now being echoed by a growing number of economists worldwide. The recently formed International Society for Ecological Economics operates under the realization that "the most obvious danger of excluding nature from economics is that nature is the economy's life-support system, and that by ignoring it, we may inadvertently damage it beyond repair," write Society members Robert Costanza and Lisa Wainger.

According to Costanza and Wainger, economists and environmentalists need not work at cross purposes. Proponents of ecological economics recommend that environmental interests be incorporated into economic planning, since a healthy economy can only exist in symbiosis with a healthy ecology. Current economic indicators do not give an adequate picture of the well-being of a country or the world, since they do not account for the value of ecological systems.



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Gross National Product, or GNP, (the total "value" of all the nation's goods and services in a given year), has become the benchmark of the general welfare. Yet GNP, as presently defined, ignores the contribution of nature to production, often leading to peculiar results. For example, the only GNP value placed on a forest is for its harvested timber. The figures do not account for the economic services it provides people by conserving soil, cleaning air and water, providing habitat for wildlife and supporting recreational activities. On the other hand, major oil spills near our country's shores have actually improved our economic performance due to the jobs created and resources consumed in the clean-up operations. From an ecological standpoint, oil spills can hardly be viewed as a "benefit." But because GNP adds up all production without differentiating between costs and benefits, it provides a skewed picture of our economic health.

What would happen if resource depletion and environmental degradation were figured into our economic profile? Herman Daly and John Cobb, in their book, *For the Common*

Good, have attempted to adjust GNP to account for depletions of national capital, pollution effects and income distribution effects by producing an "index of sustainable economic welfare" (ISEW). When charted over the last 20 years, GNP rises sharply, while ISEW remains relatively constant. They reason that losses of farms and wetlands, along with environmental and health costs of air pollution and acid rain, have countered any perceived economic progress.

Taking Nature into Account

The global goal promoted by ecological economists is a sustainable economy. "Sustainability" refers to the amount of consumption that can be maintained indefinitely without degrading capital stocks (natural resources). These capital stocks include soil, atmosphere, plants, animals and all other components of ecosystems which sustain human life. In order to preserve these natural capital stocks, we must place an economic value on them and include them in our economic accounting system. When we have determined that our ecosystems are irreplaceable and cannot be substituted with manufactured goods, they will attain high value in our economic marketplace.

The difficulty comes in placing a value on ecological goods and services, as they are long-term and not traded in markets. One approach would be to find out how much people would be willing to pay for these ecological goods and services if they had to. Another method of evaluation would be determining production costs of ecological goods and services. A forest, for instance, could be assigned a cost based on the amount of time, solar energy and water required to produce it.

Growing Together

Achieving a sustainable economy will require an international commitment to slowing population growth worldwide and reducing consumption levels of finite resources, especially in industrialized countries. Even if resources are used efficiently, consumption of water, energy and forest products will continue to rise if human numbers increase.

Ecological economists, along with many national leaders, are exploring ways of promoting development in poorer countries without producing byproducts of environmental degradation and resource depletion. In wealthier, industrialized countries, the challenge is to acquire more sustainable consumption habits.

"Despite what leading economic indicators may imply," write Sandra Postel and Christopher Flavin of the Worldwatch Institute, "no economy can be called successful if its prosperity comes at the expense of future generations and if the ranks of the poor continue to grow." Perhaps it's time to consider a new economic order—one whose bottom line is the well-being of the Earth and of all its inhabitants.

Population Growth—It All Adds Up

Student Activity 26

Concept: In a world with finite resources and an escalating human population, we must re-evaluate our perceptions of "growth."

Objectives: Students collect magazine and newspaper ads which reflect the desire for growth. This could be growth of industry, families, communities, etc. They then discuss how the ads encourage growth, whether the products or services improve the quality of life, and whether the same results could be achieved without growth.

Subjects: Economics, social studies, environmental science, family life

Skills: Data collection and analysis, critical thinking, research, discussion

Materials:

A wide variety of magazines and newspapers (including business and real estate sections of newspapers)

Introduction:

Many industries and most communities are built with the assumption that there will be ever-increasing populations—or even that growth is vital to survival. The purpose of this activity is to identify the ways industry encourages population growth and to examine the ultimate utility of such motivation. Students will re-examine the values expressed by the cliches, "growth is good" and "more is better."

Procedure:

1. Ask the students to collect ads which reflect in some way the concept of "growth." This may be an ad announcing the growth of a company into some new region or product. It may be an ad that encourages growth by the product or service it is selling. It may be a promotional ad encouraging movement into an area by industry. It could be an ad which directly or indirectly promotes childbearing and/or large families. Ads for new housing developments, shopping centers or vacation spots could also be clipped. If students have difficulty in locating enough print ads for this assignment, they can also write a brief synopsis of television or radio ads, or even describe billboards and bus ads.
2. Arrange the ads or descriptions of ads on the wall around the room so the group can see them. Allow the group 5-10 minutes to wander about the room to become familiar with the ads.
3. Begin discussion with the general question, "How do the ads encourage growth?" Some responses may be:
   a. Appeals to better quality of living (housing ads)
   b. Appeals with tax incentives (chamber of commerce ads for industry)
   c. Appeals to the right location (access to resources, markets, etc.)
4. Once the kinds of appeals have been identified, the focus should shift to the general question: "Does the product or service really improve the quality of life?" A variety of more specific questions should be used to get at the answer to this question:
   a. How does the product or service limit the quality of life? (Look at the negative side.) For example, a new subdivision of quality homes may appear to be an improvement on the surface, but consideration should be given to such things as the additional demands on resources.
   b. What other factors must also be considered? An ad to invite industry into an area also implies needs for community planning, support services, etc.
   c. What, specifically, is being improved? Often, this becomes a difficult answer to ferret out of a glamour ad.
5. A final question to be raised in this discussion should be, "Could the same results be achieved without the growth that is being advocated?" Answers to this question will require some creative thinking on the part of individuals in the group. The solutions they are now looking for have not been extensively explored. However, the whole growth scheme must be assessed carefully in a world that is becoming acutely aware of its finite resources and continued population growth rates.

Follow-up Activities:

1. Economic growth and population growth often come into conflict with environmental quality and aesthetic beauty. Many communities throughout the United States have proposed moratoriums on growth to preserve an area's livability. Arrange for students to attend a local city council meeting, chamber of commerce meeting, or local planning commission meeting to observe discussions on growth in their local areas and draft a report of their findings.
2. In recent years, numerous ads have appeared promoting products or services which claim to help the environment. These products include anything from water conservation devices to unbleached toilet paper and all-natural cosmetics. Have students collect ads promoting "ecologically sound" products and services. They should examine these ads critically to determine if, in fact, these items aid environmental preservation.

Adapted with permission from the University of Denver Center for Teaching International Relations. The original activity appears in Teaching About Population Issues, *by George Otero, Jr. and Richard Schweissing, Center for Teaching International Relations, University of Denver, CO, 1977.*

Changing Values

Student Activity 27

Introduction:

A *value* is a principle or belief that is regarded as being desirable by an individual or a group of individuals. There is often an emotional attachment to values. People and their societies have certain values because these values serve various desires and/or needs. But the situations of people's lives change with time and often so do their values. The values of past generations do not always meet our present needs.

Certain junctures in the course of world history have brought about a change in values. For example, as people become more concerned about the environment, they may rethink their habits and beliefs. Long-held economic values may also change as nations become more interdependent.

Procedure:

Listed on the Student Worksheet are some of the principles and beliefs that have been widely held by Americans in the past. Some of these values are still held; others have been replaced by new values. If the value listed is still widely held in the community, students should state "no change." If the value listed has changed or is changing, they should state the new value that has replaced it or is replacing it. Students should also state briefly what they believe is the cause of the change. (Note: A diversity of opinion should be tolerated.)

Discussion:

1. Of the ten values listed, how many have changed? How many do you think have changed for the better? For the worse?
2. Are there any that have not changed that you would like to see changed?
3. Are there any economic, social or environmental values which you hold that are different from those of your parents? Your grandparents?

Follow-up Activity:

Divide the room in half. For each value stated, have those students who believe the value is still held stand on one side of the room, and have those who believe the value has changed or is changing stand on the other side. Students can now debate and defend their positions.

Adapted with permission from Kendall/Hunt Publishing Company. The original activity, "The Olden Days," appears in Global Science: Energy, Resources, Environment Laboratory Manual. *Copyright 1981, 1984, 1991 by Kendall/Hunt Publishing Company.*

Concept: Changes in the global economy and environment often affect the values held by individuals and the larger society.

Objective: Students examine principles that have been traditionally held in the United States and determine whether they have changed in recent years, stating the cause for these changes.

Subjects: Economics, social studies, family life

Skills: Reasoning, values clarification

Materials:
Copies of Student Worksheet

Changing Values

Student Worksheet

A *value* is a principle or belief that is regarded as being desirable by an individual or a group of individuals. There is often an emotional attachment to values. People and their societies have certain values because these values serve various desires and/or needs. But the situations of people's lives change with time, and often so do their values. The values of past generations do not always meet our present needs.

Listed below are some of the principles and beliefs that have been widely held by Americans in the past. Some of these values are still held; others have been replaced by new values. If the value listed is still widely held in the community, state "no change." If the value listed has changed or is changing, state the new value that has replaced it or is replacing it. Then state briefly what you believe is the cause of the change.

1. It is important that we have economic growth.

2. People ought to have large families.

3. Be productive.

4. Everyone has the right to have as many children as he or she wants.

5. Everyone has the right to own a car.

6. Americans have a right to the resources of the world.

7. Material wealth is a measure of your worth as an individual.

8. There is no problem that science and technology can't solve.

9. The bigger the better.

10. All available land should be used for development.

The World's Women

Women: The Critical Link

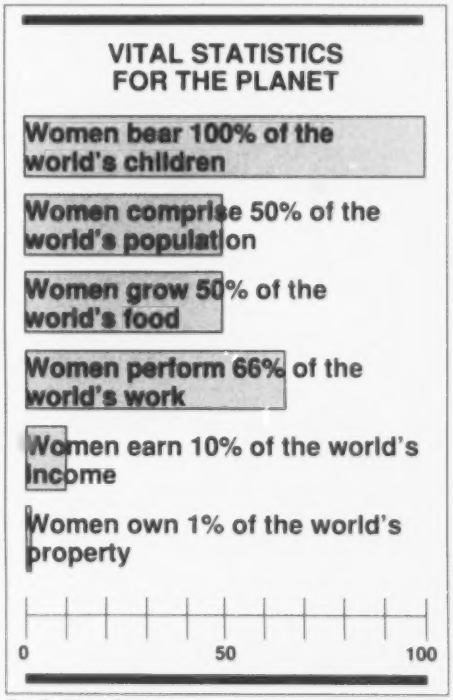
Student Reading

"Women hold up half the sky," reads an old Chinese saying. Indeed, women have traditionally been the world's farmers, childbearers and caretakers of young and old—the backbone of families and societies. Despite their vast contributions to humanity, women continue to suffer from gender discrimination in much of the world. Being born female in most of the developing world means a lifetime as a second-class citizen, denied most of the opportunities available to males. This is evidenced in areas of education, employment, health and legal rights. Due to a woman's traditional role as childbearer and food cultivator in less developed countries, her status is closely linked to population growth and environmental quality.

For many women the future is easy to predict: young brides, then young mothers. In many countries, there are few choices in life for women outside marriage and children. According to the U.N. World Fertility Survey, approximately 50 percent of African women, 40 percent of Asian women, and 30 percent of Latin American women are married by the age of eighteen. Men tend to marry at older ages. Family pressures and cultural expectations dictate that these young wives bear many children, especially sons, as soon as possible, since their labor provides economic security for the family. Unless highly educated, women are often caught in a vicious cycle of ignorance, childbearing, overwork and poor health.

Cycle of Poor Health

Women's health and nutrition suffer throughout their lifetimes in developing countries. Every pregnancy is a drain on a woman's health reserves. Anywhere from 20 to 45 percent of women of childbearing age in the developing world do not eat the recommended 2,250 calories each day under normal circumstances, let alone the extra 285 calories needed during each day of pregnancy. Husbands and sons take priority at mealtime, so women often are the last to eat. Nutritional anemia, characterized by a low red blood cell count, afflicts half of all women of childbearing ages in less developed countries, compared with less than seven percent of women of those ages in developed countries. Heavy and manual work during pregnancy compounds the detrimental effects of anemia. This poor nutrition leads to poor health, and therefore to unhealthy babies. One in six newborns worldwide weighs less than 5.5 pounds. Underweight girls are particularly vulnerable to infection, but many cultures place less significance on female survival, and therefore provide less food for the females. In Bangladesh, malnutrition is four to five times more common among girls than among boys. The preference for sons is also evident through the medical attention given during an illness. A daughter often does not receive prompt medical attention. Her parents will usually rely on home remedies, while sons will be given more expert care. These conditions affect her childbearing capabilities in the years that follow.


VITAL STATISTICS
FOR THE PLANET
Women bear 100% of the world's children
Women comprise 50% of the world's population
Women grow 50% of the world's food
Women perform 66% of the world's work
Women earn 10% of the world's income
Women own 1% of the world's property
0
50
100

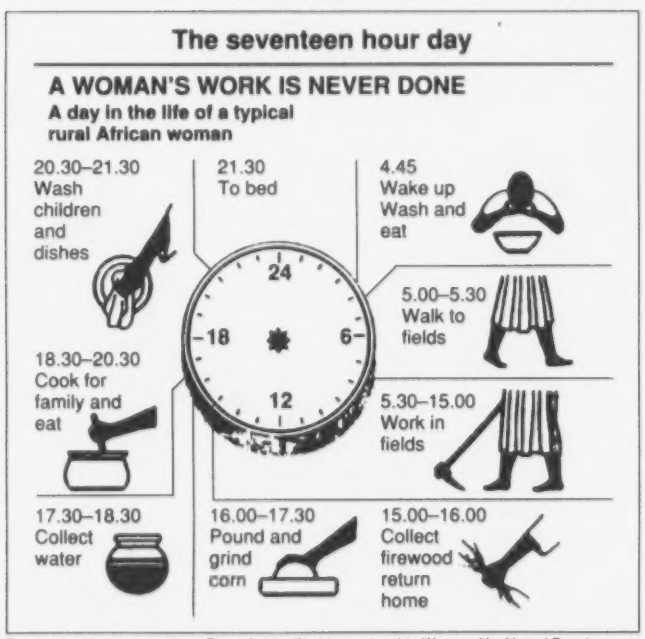
Zero Population Growth, Inc.

Because females in less developed countries tend to marry young, they often become pregnant before their bodies have adequately developed to carry and bear children. This fact, along with a legacy of poor health care and nutrition, puts young women at great risk of maternal mortality. An alarming one out of every 21 African women dies as a result of pregnancy or childbirth, 200 times the rate of European women.

The Working Woman

Tradition also plays a part in the economic role of women. Women perform two-thirds of the world's work, yet earn only one-tenth of the world's income. Throughout the world, women comprise a minority of the paid labor force. In the Middle East, where religious traditions limit women's activities outside of the household, the ratio of women to men in the labor force is reportedly a low 29 percent. Cultural traditions limit women's access to gainful employment in Northern Africa and Latin America. Despite considerable regional variations, there are signs that the trend in most of the world is toward greater visibility of women in the economic sphere.

While women are becoming more visible in the work force, their traditional household contributions should not be dismissed. Much of the work that women do each day, although it is unpaid, contributes toward the economic development of their countries. In less developed countries, the majority of women's daily activities usually revolve around the production of food, both for their families and for trading and selling in local markets. Women grow at least 50 percent of the world's food, and as much as 80 percent in some African countries. One-third to one-half of all agricultural laborers in less developed countries are women.


The seventeen hour day
A WOMAN'S WORK IS NEVER DONE
A day in the life of a typical rural African woman
20.30–21.30 Wash children and dishes
21.30 To bed
4.45 Wake up Wash and eat
5.00–5.30 Walk to fields
5.30–15.00 Work in fields
15.00–16.00 Collect firewood return home
16.00–17.30 Pound and grind corn
17.30–18.30 Collect water
18.30–20.30 Cook for family and eat
24
6
12
18

Reprinted with permission from Bread for the World, as printed in *Women, Health and Development.*

Rural women play a crucial role in environmental management. As farmers, stock breeders, and suppliers of fuel and water, they interact closely with the environment. In many societies, women carry on the traditions of ecologically sound methods of food production, if the materials are available. They have extensive knowledge of the regional crops and agricultural techniques, but are often forced to compromise in order to survive.

Environmental destruction in the forms of land degradation, deforestation and water pollution forces women to spend more time each day in search of basic necessities. Many women know that although certain actions taken for short-term survival can further erode their future and their children's future, they have no choice. For example, in countries with a shortage of fuel wood, women resort to manure as a fuel instead of saving it as fertilizer for their gardens. According to a U.N. Population Fund report, every ton of fertilizer burned can cost as much as 110 pounds of grain lost from the next harvest.

Although women have close ties to the land, they are often denied the right to own and inherit that land which is critical for their survival. In Peru, recent land reform legislation denies peasant women access to the land that they had previously owned. In Nepal, where women perform 70 percent of all agricultural work, daughters are denied the right to inherit their fathers' land leases.

Home From School

Women also come up short in terms of educational opportunities. Currently, 50 percent of women in less developed countries are illiterate, compared to 32 percent of men. In many African and South Asian countries, four out of five women over 25 years of age have had no schooling. The initial problem in women's education is getting girls into school and keeping them there. High dropout rates and low enrollment figures persist—as parents send their sons to school and keep their daughters home to help with chores.

Levels of education and family size are closely linked. For example, in Bangladesh one study revealed that only eight percent of

unschooled women used contraceptives. That figure increased fivefold for women with a secondary or higher level of education. According to the World Fertility Survey, the education of women results in lower birthrates, later marriages, improved family health and a dramatic decrease in infant mortality. The United Nations has launched a specific campaign to eradicate women's illiteracy by the year 2000.

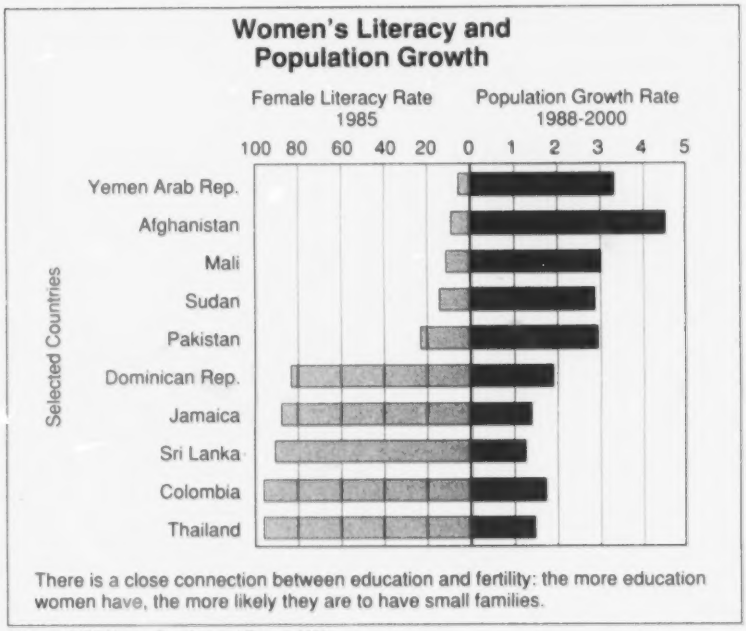
Family Planning Offers Choices

In addition to educational opportunities, family planning services are essential to ensuring women's progress. Although hundreds of millions of women wish to limit their family size, many do not have access to modern, effective contraceptives. Family planning programs can offer women a broad range of benefits: wider spacing of births, smaller family size, and fewer pregnancies during adolescence. Family planning can also mean the difference between life and death. According to the World Health Organization, one million or more women die each year from pregnancy-related causes. In virtually all developing countries surveyed, the majority (50 to 90 percent) of married women of childbearing ages want either to limit or space births.

Family planning needs to be coupled with education programs targeted to each specific culture, so as not to be implemented incorrectly or misunderstood by the very people it is supposed to be helping. For example, recent research in Liberia discovered that fear of side effects was the most important reason why women were not using family planning.

According to the U.N. Population Fund, there would be 35 percent fewer births in Latin America, 33 percent fewer in Asia and 27 percent fewer in Africa if women were able to have the number of children they wanted. Allowing this to become reality would lower infant mortality, improve the status of women, and reduce the population growth which exacerbates most environmental problems.

The key to a healthy planet includes social equality. Promoting the health, economic and educational status of the world's women will guarantee a better quality of life for all.



There is a close connection between education and fertility: the more education women have, the more likely they are to have small families.

Source: UNDP Human Development Report, 1990

A Woman's Place

Student Activity 28

Concept: The status of women in regions throughout the world influences fertility rates, and therefore the rate of population growth.

Objectives: Students will read a passage and discuss the status of women in India. Then, in cooperative learning groups, students will develop brief oral reports on the status of women in different countries, based on independent research.

Subjects: Social studies, family life, women's studies, language arts

Skills: Cooperation, observation, interpretation, public speaking, research

Materials:
Copies of Selected Reading and Student Worksheet

Procedure:

1. Copy and distribute both the Suggested Reading on the life of a typical woman in an Indian village and the Student Worksheet. After students have had a chance to read the passage and complete the Student Worksheet, go through the discussion questions as a class.
2. Divide the class into groups of four students. You may wish to assign students to groups ahead of time to provide for a diversity of strengths, personalities, etc. In cooperative learning activities, it is often best for students not to work in familiar cliques.
3. Each group will be assigned one of the following countries to research (if the class has fewer than 32 students, eliminate countries from the list):

Pakistan	China
Brazil	Nigeria
Saudi Arabia	Poland
Australia	Jamaica

4. Each student will have a specific area to study related to the status of typical women in his or her group's assigned country. Each student will research one of four categories:
   - **Education of women** (includes literacy rate, average years of schooling)
   - **Employment of women** (includes employment rate, types of employment, average wages, labor in the home)
   - **Health of women** (includes life expectancy, vulnerability to disease, nutrition, fertility)
   - **Legal and political status of women** (includes women's rights, laws relating to women's status, representation in government).

   For instance, if a group is assigned to research Pakistan, each group member will focus on one of the above four categories related to women's status in Pakistan. For each category, students should determine how women's opportunities compare to those of men.

   Reference materials such as world almanacs and encyclopedias may be helpful, but students should seek out any other resources in their school or local library that will provide them with some facts and figures.

   Allow two or three days for students to accumulate information on their particular categories. Then students should meet in their groups and share information on their findings. Together, group members will create a brief oral presentation on the status of women in their assigned country. The presentation may include visual aids, such as a poster or a skit, and may be presented by a group representative or all four group members. Groups should also be encouraged to present any findings on efforts to change the status of women in their assigned country if this information is available.
5. After all groups have presented their findings, lead a discussion on the similarities and differences in the reports. In which countries is women's status closest to that of men? In which countries do women have the lowest status? How is the fertility rate in each region related to the status of women? How is the status of women related to population growth? To environmental quality?

Suggested Answers to Student Discussion Questions:

1. Sons are prized in Indian society because they are relied upon to financially support parents in retirement. Once married, daughters usually live with and take care of their in-laws. Women who fail to bear sons may be viewed with pity or contempt.
2. By the standards listed, an Indian woman's status is much lower than that of Indian men. However, women have been known to hold high political office, such as Indira Ghandi, India's former prime minister.
3. Because an Indian woman's status is influenced by her childbearing activities, many women desire large families. This cultural tradition has presented obstacles to the success of national family planning programs.

Follow-up Activity:

Students can examine how women's roles worldwide are closely tied to environmental quality and conservation. After listing connections, students should brainstorm programs which would alleviate environmental stresses while improving women's status in a given society.

A Woman's Place

Suggested Reading

The following is an excerpt from May You Be the Mother of a Hundred Sons *by Elisabeth Bumiller (New York: Random House, 1990), pp. 11-12.*

The "typical" Indian woman, representing about 75 percent of the 400 million women and female children in India, lives in a village. She comes from a small peasant family that depends on the whims of the big farmers for sporadic work and wages. She can neither read nor write, although she would like to, and has rarely traveled more than 20 miles from her place of birth. In many cases, she does not know who the prime minister of India is and cannot identify her country on a map. Sometimes she does not know about the existence of her own village *panchayat,* or governing council, but even if she does, she is rarely aware that there is a place reserved for a woman member, because only men attend the meetings. She does not own land in her own name, or even jointly with her husband. She believes that she catches colds and fevers from evil spirits that lurk in trees. Her occupation is field work, chiefly harvesting, planting and weeding, for which she often receives less than 50 cents a day—in many cases, half the wage that a man receives for the same amount of work.

She has to juggle this labor with her other full-time job, the care of the house and the children. Her husband does not help her; indeed, he does not even consider what she does at home as work. No American woman who struggles with family and career can completely imagine what this means in India. A village woman starts her life from scratch every day. Even a single *chapati,* the Indian flat bread, has behind it a chain of drudgery that has not changed in thousands of years. To make a *chapati,* a woman needs water, which is often several miles away by foot. She also needs wheat, which she must harvest by scythe, under a blazing sun, in a back-breaking bent-forward motion, and then grind by hand. To cook the bread she needs fuel, either firewood, which she collects herself, or cow-dung cakes, which she makes herself. To get the dung she must feed the cow, and to feed the cow she must walk several miles to collect suitable grasses. (This assumes the family is lucky enough to even have a cow; many do not.) The bread is at last prepared over a small mud stove built into the dirt floor of her hut. While she cooks, she breast-feeds one child and watches three others. If she fails in any of these tasks, or performs them too slowly, her husband often feels it is his prerogative to beat her.

A woman like this may begin producing babies as early as age fourteen. She delivers them on the floor of her hut, usually with the help of her mother-in-law or a *dai,* an untrained village midwife. There is a good chance the child will grow up malnourished, with iron and vitamin A deficiencies, and without basic inoculations to protect against polio, typhoid, diphtheria and tetanus. One in ten children in India will not live to be a year old. If the child is a girl, there is an even smaller chance that she will survive, even though girls are biologically stronger at birth than boys. This is because the girl will often be given less food and care than her brother. Assuming she lives, she may go, erratically, to a one-room village school but will be pulled out whenever her mother needs help with the other children and the chores in the house. Her education is over when she is married off as a teenager to a young man she has never met; from then on, she will begin a new life with her husband's family as a virtual beast of burden.

A Woman's Place

Student Worksheet

Discussion Questions:

1. The student reading was an excerpt from a book entitled *May You Be The Mother of A Hundred Sons.* This is a common blessing wished upon Indian women at their weddings. What is meant by this blessing? Why are sons so important in Indian society? What might be the implications for women who bear only daughters or for those who have no children at all?

2. Indicators that determine women's status in a society include: education, health, employment status, legal equality and representation in government. By these standards, how would you evaluate the status of women in India as compared to men? Are there any areas of Indian society where women's status may seem higher than in other areas?

3. How does the status of Indian women affect fertility patterns in India? Why do you think this is so?

A Visit From Gynog

Student Activity 29

Concept: Gender equality issues are not restricted to the developing world. Even in the United States, there are observable differences between men's and women's roles in society.

Objective: Acting as anthropologists from a distant world, students will examine American culture to determine the status of women in the United States.

Subjects: Social studies, family life, women's studies, language arts

Skills: Cooperation, observation, interpretation, public speaking, research

Materials:

Copies of Student Worksheet

Procedure:

In cooperative learning groups, students will now shift their focus from viewing women in other cultures to viewing women in the United States.

Detach the Student Worksheet below, copy and distribute. Break the class into groups of four to six people and allow students two or three days to collect their data. Each group can then report its findings and conclusions to the entire class.

Cut here.

A Visit From Gynog

Student Worksheet

You will assume the role of an anthropologist from Gynog, a mythological planet from a distant galaxy. As on Earth, there are two genders of people on Gynog. The two genders enjoy total equality with regard to status and responsibility. They have achieved equal levels of education, employment in all professions and governing positions on Gynog. Wealth no longer determines status on Gynog as everyone has more than enough for their needs. Although there are a few biological differences between the genders on Gynog, both genders are able to give birth to their progeny.

Anthropologists from Gynog participate in numerous expeditions to other planets to study exotic cultures. Your team has been dispatched to planet Earth and all team members will be "beaming down" to the North American continent for field research. You will divide into small groups and each group will report their findings.

Your assignment is to study American culture with respect to gender issues of the human species. You will try to determine whether the genders share an equal place in society as they do on Gynog. Because scientific technology on Gynog is rather advanced, you have the ability to make yourself invisible to earthlings or to assume a human appearance. Most of your clues will come from what is easily observable: the interaction of the genders in public places, the depiction of the genders in the media, books, songs, television, movies, advertisements, etc. Also examine their laws and daily rituals. Every time you find a clue, you will record it in your notebook. Group members may do some of their field research individually and some in groups.

After several days of collecting data, draft a complete list of your team's findings and draw conclusions to bring back to address the Gynog Academy of Social Sciences.

BEST COPY AVAILABLE

Eco-Ethics

Student Activity 30

Concept: Lessons on population, environment and the global society should have their applications in daily personal decision making.

Objectives: Students examine their own values and beliefs related to environmental issues and evaluate possible actions they might take that have an impact on the environment.

Subjects: Environmental science, social studies

Skills: Decision making, reasoning, discussion, writing

Materials:

Copies of Dilemma Cards

Introduction:

This activity is designed to give students the opportunity to examine their own values and beliefs as they relate to the environment, population and social issues. It is not the intent of this activity to prescribe "right" and "wrong" answers for the students. In some cases, students may perceive what would be the most ethical solution to a given problem, while admitting that they realistically might not choose that option. For each Dilemma Card, the action choices are preceded by "would you" rather than "should you." This will encourage students to state what they probably would do in each given situation. It might be useful to compare students' reactions to each dilemma both before and after going through the student readings and lessons.

Procedure:

1. Copy and cut out the Dilemma Cards. Other dilemmas could be written that are more specific to problems in your area. Students could also be involved in the process of creating the Dilemma Cards with each student responsible for writing one dilemma. Dilemmas can be left entirely open-ended with no options suggested for consideration.
2. Divide the class into groups of four, and give each group a complete stack of Dilemma Cards. Place them face down at the center of the group.
3. The first student draws a card from the top of the stack. The student studies the situation, decides what he or she would do, and formulates his or her reasons.
4. When the student is ready—typically in less than two minutes—the student reads the situation and the options aloud to the rest of the group. The student gives the decision he or she has chosen, and briefly describes the reasoning involved. In turn, each of the other members of the group is invited to comment on the dilemma, and what he or she would do in the situation. The discussion of each dilemma by the members of the group should take about five minutes. The person whose dilemma is being discussed should have the opportunity to ask questions of the other members of the group, and to offer clarification about his or her decision. The discussion gives the students experience in having ideas examined by peers, and is intended to remind the students of the need to take personal responsibility for decision making. It is not necessary and may not be desirable for the students to reach consensus; there are legitimately diverse views on the most appropriate and responsible actions to take in many situations. The purpose is to provide students with an opportunity to examine, express, clarify and take responsibility for their own reasoning.
5. The card is then returned to the bottom of the stack and the next student selects a card from the top of the stack. Continue this process until each student has had the opportunity to express his or her decision and rationale about a dilemma.

Follow-up Activity:

Have each student choose a dilemma and write a short paragraph on the positive and negative effects of all the options listed for that dilemma. They should indicate what, if any, additional information is needed in order to make a responsible and informed decision. Students should identify what seems, in their judgment, to be the most responsible decision, and explain their reasoning.

Adapted with permission from Project WILD. The original activity, "Ethi-Reasoning," appears in Project WILD's Secondary Activity Guide, *Western Regional Environmental Council, copyright 1983, 1985, 1987.*

DILEMMA CARD

You are president of a large corporation. You are very interested in pollution control and have assigned a task force to study the pollution your plant is creating. The task force reports that you are barely within the legal requirements. The plant is polluting the community's air and water. To add the necessary equipment to reduce pollution would cost so much that you would have to lay off 50 employees. Would you:

- add the equipment and fire the employees?
- not add the equipment?
- wait a few years to see if the costs of the equipment will drop?
- hire an engineering firm to provide further recommendations?
- other? (specify)

DILEMMA CARD

You love children and would like to have a large family. You are aware, however, that the world's population is expected to triple in the coming century. Would you:

- plan to have a large family anyway?
- decide not to have children?
- limit yourself to one or two children?
- other? (specify)

DILEMMA CARD

You are finally able to build the home your family has dreamed about. After reviewing the plans for your home, you realize that you cannot include all of the features you had planned for, due to rising construction costs. If you can only choose to include one of the following features, would you choose:

- solar heating?
- recreation room with fireplace?
- hot tub and sauna?
- greenhouse?
- other? (specify)

DILEMMA CARD

You are having a picnic with your family at the beach and you see another family leaving to go home, without having picked up their own trash. It is clear that the other family is going to leave litter all around. Would you:

- move quickly and ask them to pick up the trash before they leave?
- wait for them to leave and pick up the trash for them?
- do nothing?
- other? (specify)

DILEMMA CARD

You are an influential member of the community. On your way home from work, you are stopped by a police officer and cited for having excessive auto emissions. Would you:

- use your influence to have the ticket invalidated?
- sell the car to some unsuspecting person?
- work to change the law?
- get your car fixed and pay the ticket?
- other? (specify)

DILEMMA CARD

You have a job at a restaurant and notice that each day prepared meals are left over and are discarded. You feel this is a waste of good food, especially since many people in your city are without adequate food. Would you:

- suggest to management that leftover food be donated to a local homeless shelter?
- suggest to management that less food be prepared each day?
- do nothing?
- other? (specify)

DILEMMA CARD

You are a member of a country club that has recently voted to build a game farm to raise animals for members to hunt. You are not a hunter, you think that hunting is only okay to do in the wild, and you are opposed to the building of the game farm. Would you:

- stay in the club and do nothing?
- stay in the club and speak out strongly against the subject?
- resign from the club?
- other? (specify)

DILEMMA CARD

Your favorite lunch spot continues to use polystyrene food containers. You are aware that the production of polystyrene releases chlorofluorocarbons (CFCs) into the atmosphere. CFCs are responsible for destroying the atmosphere's protective ozone layer and contributing to global warming. Would you:

- stop buying food at that cafe?
- talk with the manager about switching to more ecologically sound containers?
- do nothing?
- other? (specify)

DILEMMA CARD

Your friend has just given you a lovely ivory necklace that she purchased on a trip to Africa. You are aware that African elephants are being slaughtered for their ivory tusks and are now an endangered species. Would you:

- accept the necklace and wear it often?
- accept the necklace but keep it in a drawer?
- explain to your friend why you do not wish to accept her gift?
- other? (specify)

DILEMMA CARD

Your cafeteria at school has attempted to prepare food items that are popular with students (hamburgers, hot dogs, pepperoni pizza, fried chicken, etc.). While you and your friends enjoy these foods, you know that most of these items are high on the food chain, requiring intensive amounts of water and energy to produce. You are also aware that much of the grain produced in this country is used to feed livestock, while much of the world suffers from hunger and malnutrition. Would you:

- meet with school administrators to suggest having more meatless lunches served each week?
- bring your own lunch and not worry about the cafeteria menu?
- eat whatever is served?
- other? (specify)

DILEMMA CARD

You live in a densely wooded area where you enjoy seeing squirrels, deer, chipmunks, rabbits and several varieties of birds on a regular basis. The house next door has just been sold to a family that wants to cultivate a large, green lawn on their entire property. This would require them to cut down over an acre of trees surrounding their home. Would you:

- tell them lawns waste water and energy?
- plead with them to preserve their wildlife habitat?
- do nothing?
- move?
- other? (specify)

DILEMMA CARD

You own a popular golf course in a semi-arid area. The area has had below-average precipitation for some time and area officials are recommending that businesses and individuals conserve water. Without regular watering your golf course will turn brown and you may start to lose business. Would you:

- ignore the conservation recommendation and continue watering your golf course daily?
- sacrifice the beauty of your golf course by watering less often?
- sell your golf course?
- other? (specify)

Think Globally, Act Locally

Student Activity 31

Procedure:

1. For each global and local challenge listed in the attached charts, have students—either individually or in groups—add as many ideas as they can think of to the personal actions/potential solutions list. You might want to compile all ideas onto one class list.
2. Next have the students assess which aspects of the global and local problem are addressed by each idea. For example, recycling car oil will help the water pollution problem and lessen health problems caused by poor quality drinking water; therefore students should write "A,1" in the *Problems Addressed* section on the chart.
3. The next two columns can be filled in together. Students should first evaluate the degree of personal commitment each idea would involve, rating the ideas: Easy, Average, or Difficult. Then students should evaluate the degree of effectiveness for each idea: Unlikely, Somewhat likely, Very likely.

Follow-up Discussion Questions:

1. Review the list of global problems related to overpopulation. Should any of the categories be changed? Any additions to or subtractions from the list? Ask students to arrange the list in order of importance or priority to them.
2. Also review the local problems list. Do any modifications seem appropriate for this list? Note similarities and differences between the global problems and local manifestations.
3. Some of the personal actions from the solutions list will positively affect more than one problem. For example, using the car less affects air pollution, global warming and energy conservation. Have students note which ideas help more than one problem and draw arrows on their chart to the other global and local challenges affected.
4. Some actions may help solve one problem while contributing to another. An example of this is switching from disposable diapers to cloth. Using cloth diapers helps the waste disposal problem, since less mass will be sent to landfills; it also requires large amounts of hot water to clean the diapers, thus contributing to the energy and water pollution problems. Have students circle the ideas which have such a dual effect and write the problem(s) negatively affected next to it.
5. Finally, discuss the intangible benefits of doing what you can to solve a problem. Is it better to take an action that, by itself, will not solve the problem, or is it better to do nothing at all?

Adapted with permission from the Office of Environmental Education, Washington State. The original activity appears in Energy, Food, and You, *published by the Office of Environmental Education, Washington State (Seattle, WA).*

Concept: To avoid becoming overwhelmed by global problems, we should concentrate on the local level, focusing on meaningful actions individuals can take to participate in global problem-solving.

Objective: Students list personal actions which will help solve many of the global challenges discussed throughout this curriculum, and then assess these actions for effectiveness and convenience.

Subjects: Environmental science, social studies, family life

Skills: Brainstorming, evaluation, critical thinking

Think Globally, Act Locally					
Global Challenges Related to Overpopulation	**Local Challenges Related to Overpopulation**	**Personal Actions/Potential Solutions**	Problems Addressed	Level of personal commitment: Easy Average Difficult	Degree of effectiveness: Unlikely Somewhat likely Very likely
Rapid Population Growth A. Too many people drain Earth's finite resources and harm the environment. B. Consumption patterns of some people cause increased damage to resources and the environment.	1. Inadequate food, shelter, education, and health services for all people 2. Most local environmental and social problems worsen with too many people	→ Write a letter to the editor about the problems of unchecked population growth. → Limit the number of children you have to two or fewer. → →			
Climate Change A. Global warming/climate change B. Ozone layer depletion	1. Water shortages 2. Crop damage 3. Disruption of marine food chain (fewer fish to eat) 4. Increase in skin cancer	→ Plant trees and shrubs in your yard. → Request that the local government set up a collection and recycling system for appliances containing CFCs. → →			
Diminishing Air Quality A. Airborne poisons B. Acid rain	1. Health problems from smog 2. Death of forests and wildlife 3. Decrease in crop production	→ Check your car for smog control devices (and use unleaded gas). → Don't spray bugs; stomp them or take them outside. → →			
Water Issues A. Water pollution B. Limited availability	1. Health problems from poor quality drinking water 2. Crops, wildlife, and people suffer from water shortages	→ Take short showers instead of baths. → Make sure your used car oil is properly recycled, not poured into the sewage system. → →			
Deforestation A. Loss of oxygen producers B. Loss of biodiversity	1. Disappearing native forests 2. Threatened extinction of several species 3. Hotter cities/homes	→ Use fewer wood products. → Contact your local forestry service about helping replant logged areas. → →			
Land Use/Hunger A. Topsoil depletion due to misuse of land B. Hunger problems	1. Loss of jobs and food produced due to overused and wasted cropland 2. More hungry people 3. Illnesses related to lack of nutrients	→ Organize a local food drive. → Eat lower on the food chain. → →			

Think Globally, Act Locally

Global Challenges Related to Overpopulation	Local Challenges Related to Overpopulation	Personal Actions/Potential Solutions	Problems Addressed	Level of personal commitment: Easy Average Difficult	Degree of effectiveness: Unlikely Somewhat likely Very likely
Waste Disposal A. Population growth creates more waste. B. Careless consumption patterns cause more waste.	1. Overfull landfills (often improperly contained and sealed) 2. Toxins from incinerators 3. Smell from large compost plants	→ Begin a local recycling program. → Buy products with minimal packaging. → →			
Loss of Biodiversity A. Plant and animal species become endangered or extinct.	1. Possible medical cures lost 2. Wildlife gene pool decreased 3. Beauty lost	→ When hiking or camping, try not to alter the natural habitat in any way. → Join a wildlife protection society and start a local chapter. → →			
Energy A. Nonrenewable resources are becoming scarce. B. Fossil fuel dependence creates environmental problems.	1. Air/water pollution cause health risks 2. Oil spills cause environmental damage 3. Political unrest due to competition for limited resources (e.g. oil) 4. Traffic jams due to auto dependence	→ Install a solar hot water heater in your home. → Organize a car pool system for local commuters. → →			
Poverty/Homelessness A. Additional numbers needing food/shelter make economic growth difficult, perpetuating the poverty cycle. B. Wealth is unevenly distributed.	1. Inadequate food and shelter for many 2. Health and literacy levels are low	→ Organize a food and clothing drive for a local charity. → Volunteer to tutor at a local homeless shelter. → →			
Status of Women A. Women have many children when they are most valued for bearing sons. B. Without education, women often do not know how to obtain and use family planning methods.	1. Women have families which are too large to support 2. Women miss opportunities to be anything other than caretakers	→ Write letters of encouragement to local women who are positive role models. → Inform your legislators that you support measures to help raise the status of women both domestically and internationally. → →			

A Nonbearing Account

Student Activity 32

Concept: Creative approaches are often necessary in finding solutions to complex problems such as overpopulation.

Objectives: Students examine and analyze a proposal for combatting overpopulation. They then devise their own creative proposal to address overpopulation.

Subjects: Language arts, social studies

Skills: Critical thinking, creativity, discussion, writing

Materials:

Copies of Suggested Reading, "A Nonbearing Account"

Introduction:

In the following article, "A Nonbearing Account," Professor Noel Perrin outlines his plan for lowering fertility rates in an effort to curb population growth. He describes why the program is necessary, how it should be implemented, and the anticipated costs and benefits.

Procedure:

Distribute copies of "A Nonbearing Account." After students have had a chance to read the article, lead a discussion using the following questions.

1. What do you think of Perrin's idea to pay females of childbearing age not to have children?
2. Do you think his idea would work in the United States, significantly decreasing fertility rates? Would many women decide against childbearing entirely?
3. What segments of the U.S. population might look favorably on Perrin's proposal? What segments of the population might regard Perrin's proposal with scorn? Explain.
4. Perrin compares the financial costs of his plan to current costs of the U.S. welfare system. Do you think implementation of his plan would significantly reduce federal assistance to the indigent?
5. What do you feel is Perrin's attitude toward the status of women in the United States? In developing countries?
6. Do you think Perrin's plan would be possible to implement? Is it realistic?
7. Perrin notes that there is a precedent for governments paying women to have children. What sort of precedents might he have in mind? Can you think of any ways the U.S. government encourages childbearing? (Note: Perrin is most likely referring to tax incentives to have children.)
8. Do you think Perrin wrote this article to seriously win support for his plan or just to heighten awareness of overpopulation by offering a "modest proposal"?

Follow-up Activity:

Have students draft their own "modest proposal" for combatting overpopulation nationally or globally, working either individually or in pairs. The proposal should clearly outline the necessity of the plan, logistics, costs and benefits. Students should be as persuasive as possible in their writing assignment.

A Nonbearing Account

Suggested Reading

by Professor Noel Perrin

Sometime in 1987 world population hit five billion. Sometime a little before 2000 it will hit six billion. Sometime around 2010 . . . Obviously growth like this can't continue indefinitely. We'll run out of parking space for all the cars. We'll run out of flight paths for all the airplanes. We'll eventually run out of essentials like food. A country like Nepal has already run out of firewood.

But how do you stop the relentless increase of humanity, currently proceeding at the rate of almost two million a week? Well, the interesting idea I've heard is to do it with money. More specifically, bank accounts. One for every woman in the world. Forget the rest of the world for a minute: here is how the plan would work in the United States. Every girl, when she reached puberty, would notify her local population center. (These sunny offices had better be staffed entirely by women—well-paid ones, too.) At that moment a financial clock would start ticking.

If the girl went the next year without having a baby, she would get a government check for $500, placed in the bank account the center now opened for her. She could take it all out and spend it on angora sweaters, if she wanted. She could leave it in as the beginning of a fund for college. Whatever she liked. The next year, if she still hadn't had a baby, the government would increase the sum by a hundred, so that her second check would be for $600. The year after, $700. A young woman reaching the age of 20, and still not having had a child, would receive a check for around $1,200. No fortune, but worth having. Available without any discrimination of any kind. A Miss du Pont, an ordinary kid in Topeka, an intending nun, a teenage prostitute, all would get their checks.

Suppose the young woman wants a child, though. There's nothing to stop her, except a little financial self-interest. If at 21 she proceeded to have a baby, fine. Let's have a baby shower. The government payment, however, would abruptly drop to zero. But then, if she did not have another baby the next year, back would come a check for $500. If she went two years, she'd get $600, and so on up the modest pay ladder. A pleasant little extra income for the sex that has historically been underpaid.

Great bargain: What would all this cost? In the case of women who never do have children, plenty. Start at 13 with a check for $500 and by the time you reached menopause at 53, the check would be $4,500. To that point, you would have received a total of almost $100,000. A lot of money. But still a bargain. A great bargain. The same $100,000 is about half the cost of bringing up one abandoned child in New York City. It's less than a fifth the cost of bringing up one psychologically disturbed child in a group home in the District of Columbia. The total cost the first year would be about a billion dollars in payments to girls, maybe two/three billion to set up the centers. The total cost the fifth year would be around $10 billion. The cost wouldn't level off for about 40 years—and when it did, it would still be under what we now pay as welfare. And most of the money would flow back out immediately to stores or get turned over somewhat later to happy bursars at colleges.

Do I possibly exaggerate when I say that when the plan was in full operation, and every woman in the country between puberty and menopause receiving her check, the cost would still be less than that of the current welfare system? I don' t think I do. Try looking in the *Statistical Abstract of the United States.* The current figure is $770 billion a year—$298 billion in state and local money, $472 billion from the federal government. That table covers many things, including VA hospitals. So turn to a more modest table, the one called "Cash and Noncash Benefits for Persons With Limited Incomes." Here the total is $114 billion, all federal money.

Such a plan would be much harder to implement in, say, India, where most people don't have bank accounts and where the government would be hard pressed to find the funds. But it wouldn't be impossible. Such payment could be the first-ever democratic foreign aid—putting money directly in the hands of women, rather than in the pockets of businessmen and bureaucrats. Furthermore, India has already found ways to pay men to have vasectomies.

Of course there are problems with such a plan. Men will object to all this money going to women, money being power. There are bound to be accusations of racism, even though the offer would be voluntary, universal and totally color blind. There being no precedent (though there's plenty of precedent for the opposite case: governments paying women to *have* children), it would be hard to get started. The more stolid type of politician will call the plan impossible, utopian, dreamy, absurd.

But consider the alternatives. One, of course, is to go on exactly as we are—adding a billion people every few years until there is no more tropical forest, no more oxygen-carbon dioxide balance, no more space, and our world collapses in disaster. Another is nuclear war. A third (the likeliest, I expect) is mandatory birth control, starting one country at a time, with all the repression that implies. The repression is already there in China. And with the rigid immigration restrictions imposed by those countries that have started early against those that start late. Maybe even with population wars. How much more graceful to do it all with checks.

Noel Perrin is professor of English at Dartmouth College. He has written for The New Yorker *and* New York *magazine.*

Reprinted with permission from Noel Perrin. The original article appears in Newsweek, *April 2, 1990.*

Suggested Resources for Further Research

POPULATION DYNAMICS

BOOKS:

Gaining People, Losing Ground: A Blueprint for Stabilizing World Population, by Werner Fornos. Washington, DC: The Population Institute, 1987. 121 pp.

The Peopling of Planet Earth, by Roy Gallant. New York: Macmillan Publishing Company, 1990. 163 pp.

Planning the Ideal Family: The Small Family Option, by Zero Population Growth. Washington, DC: ZPG, Inc., 1990. 24 pp.

The Population Explosion, by Drs. Paul and Anne Ehrlich. New York: Simon and Schuster, 1990. 320 pp.

100 Predictions for the Baby Boom: The Next 50 Years, by Cheryl Russell. New York: Plenum Press, 1987. 249 pp.

The State of World Population, by Dr. Nafis Sadik. New York: UN Population Fund. This is an annual free publication.

USA by Numbers: A Statistical Portrait of the United States, by Zero Population Growth. Washington, DC: ZPG, Inc., 1988. 164 pp.

FACT SHEETS:

Demographic Facts of Life, ZPG*
Fact vs. Fiction: The Birth Dearth, ZPG*
Sustainability: The Global Challenge, ZPG*
Setting a Limit, ZPG*
Teens: A Generation of Difference, ZPG*

PERIODICALS:

Population Today, Population Reference Bureau, 1875 Connecticut Avenue, NW, Suite 520, Washington, DC 20009-5728; 202/483-1100.

Populi, United Nations Fund for Population Activities, 220 East 42nd Street, New York, NY 10017; 212/850-5842.

ZPG Reporter, Zero Population Growth, 1400 16th Street, NW, Suite 320, Washington, DC 20036; 202/332-2200.

HANDBOOKS AND WALL CHARTS:

Life Expectancy at Birth and Population Growth Rate, (wallchart and activities) 1987. World Bank Publications, Department 0552, Washington, DC 20073-0552; 202/473-1155.

Population Handbook, 1985. Population Reference Bureau, 1875 Connecticut Avenue, NW, Suite 520, Washington, DC 20009-5728; 202/483-1100.

World Access to Birth Control, (wallchart) 1987. Population Crisis Committee, 1120 19th Street, NW, Suite 550, Washington, DC 20036; 202/659-1833.

World Population Data Sheet, and **United States Population Data Sheet,** (wallcharts) published annually. Population Reference Bureau, 1875 Connecticut Avenue, NW, Suite 520, Washington, DC 20009-5728; 202/483-1100.

AUDIOVISUAL AIDS:

Population Patterns and Technology, 20 min. (video), 1988. Available from the Agency for Instructional Technology, Box A, 1111 West 17th Street, Bloomington, IN 47404-3098; 800/457-4509.

What is the Limit?, 23 min. (video), 1987. Available from the National Audubon Society, 801 Pennsylvania Avenue, SE, Suite 301, Washington, DC 20003; 202/547-9009.

World Population, 6 min. (film and video), 1990. Available from Zero Population Growth, 1400 16th Street, NW, Suite 320, Washington, DC 20036; 202/332-2200.

Note: All of the above films are also available for rent from the Population Reference Bureau, 1875 Connecticut Avenue, NW, Suite 520, Washington, DC 20009-5728; 202/483-1100.

SOFTWARE:

MANRGY, from Diversified Educational Enterprises, Inc., 725 Main Street, Lafayette, IN 47901; 317/742-2690.

POPGRO, from Diversified Educational Enterprises, Inc., 725 Main Street, Lafayette, IN 47901; 317/742-2690.

POPSHOW, from Duke University Press, 6697 College Station, Durham, NC 27708; 800/338-5578.

Population Concepts, from Educational Materials and Equipment, Old Mill Plain Road, P.O. Box 2805, Danbury, CT 06813-2805; 203/798-2050.

Population Growth, from the following vendors:

Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215; 800/334-5551.

Conduit, University of Iowa, Oakdale Campus, Iowa City, IA 52242; 800/365-9774.

Queue, Inc., 338 Commerce Drive, Fairfield, CT 06430; 800/232-2224.

Population Pyramids, WISC-WARE, University of Wisconsin at Madison, 1210 West Dayton Street, Madison, WI 53706-1685; 800/543-3210.

Note: ZPG's *Computer Software for Population Education* contains a more complete list of software, including descriptive reviews. This booklet is available for $1.95 from Zero Population Growth, 1400 16th Street, NW, Suite 320, Washington DC 20036; 202/332-2200.

CLIMATE CHANGE

BOOKS:

The Changing Atmosphere: A Global Challenge, by John Firor. New Haven: Yale University Press, 1990. 145 pp.

Climate in Crisis: The Greenhouse Effect and What We Can Do, by Alfred Bates. Summertown, TN: The Book Publishing Co., 1990. 228 pp.

Global Warming, by Stephen Schneider. San Francisco: Sierra Club Books, 1989. 317 pp.

Greenhouse Earth: Tomorrow's Disaster Today, by John Erickson. Tab Books, Inc., 1990. 167 pp.

The Greenhouse Trap, by Francesca Lyman, et. al. Boston: Beacon Press, 1990. (A World Resources Institute book.) 190 pp.

One Earth, One Future: Our Changing Global Environment, by Cheryl Simon Silver. Washington, DC: National Academy Press, 1990. 196 pp.

FACT SHEETS:

Global Warming: A Primer, ZPG*

Population and the Greenhouse Effect, ZPG*

PERIODICAL:

Greenhouse Gas-ette, Climate Protection Institute, 5833 Balmoral Drive, Oakland, CA 94619; 415/531-0100.

AUDIOVISUAL AIDS:

Global Warming—Future Quest, 31 min. (video), 1990. Produced by and available from Hawkhill Associates, Inc., 125 East Gilman Street, P.O. Box 1029, Madison, WI 53701-1029; 800/422-4295.

Greenhouse Crisis—The American Response, 11 min. (video), 1990. Produced by and available from the Union of Concerned Scientists, 26 Church Street, Cambridge, MA 02238; 617/547-5552.

The Greenhouse Effect, 25 min. (video), 1988. Produced by Scott Resources. Available from Social Studies School Service, P.O. Box 802, Culver City, CA 90232-0802, 800/421-4246.

Once and Future Planet, 23 min. (video), 1990. Produced by John Stern for King Broadcasting Company. Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG.

Spaceship Earth: Our Global Environment, 25 min. (video), 1990. Produced by Worldlink. Available from The Video Project, 5332 College Avenue, Suite 101, Oakland, CA 94618; 415/655-9050.

AIR POLLUTION

BOOKS:

Going Sour: The Science and Politics of Acid Rain, by Roy Gould. Cambridge, MA: Birkhauser Boston, 1985. 155 pp.

High-Tech Holocaust, by James Bellini. San Francisco: Sierra Club Books, 1986. 260 pp.

Sowing the Wind: Reflections on the Earth's Atmosphere, by Louise B. Young. New York: Prentice-Hall Press, 1990. 207 pp.

The Toxic Cloud: The Poisoning of America's Air, by Michael H. Brown. New York: Harper & Row, 1987. 300 pp.

FACT SHEET:

Population Exhausts Solution to Pollution, ZPG*

AUDIOVISUAL AID:

Acid Rain: The Choice is Ours, 20 min. (slide show), 1980. Produced by Friends of the Boundary Waters Wilderness. Available for rent from the Sierra Club, 730 Polk Street, San Francisco, CA 94109; 415/776-2211.

WATER RESOURCES

BOOKS:

But Not a Drop to Drink! The Lifesaving Guide to Good Water, by Steve Coffel. New York: Rawson Associates, 1989. 323 pp.

Marine Pollution, by R.B. Clark. Oxford: Clarendon Press, 1989. 220 pp.

Protecting Water Quality, edited by Gary E. McCuen. Hudson, WI: G.E. McCuen, 1986. 180 pp.

Troubled Water, by Jonathan King. Emmaus. PA: Rodale Press, 1985. 230 pp.

FACT SHEETS:

In Troubled Waters, ZPG*

Assaulting the Seas, ZPG*

AUDIOVISUAL AIDS:

Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG:

Downwind, Downstream: Threats to the Mountains and Waters of the American West, 58 min. (16mm or video), 1988. Produced by Robert Lewis and Christopher McLeod in association with Environmental Research Group, Aspen, CO.

Into Deep Water, 26 min. (video), 1988. Produced by George Courtice for Tyne Tees Television.

Pointless Pollution, 28 min. (video), 1989. Produced by Wayne Ewing for Lower Colorado River Authority.

Groundwater: What Is It?, 11 min. (slide show and cassette), 1990. Produced and distributed by Cornell University, Distribution Center, 7-8 Cornell Business and Technology Park, Ithaca, NY 14850; 607/255-2091.

DEFORESTATION

BOOKS:

The Fate of the Forest: Developers, Destroyers, and Defenders of the Amazon, by Susanna Hecht. New York: Verso, 1989. 566 pp.

Fragile Majesty: The Battle for North America's Last Great Forest, by Keith Ervin. Seattle: The Mountaineers, 1989. 272 pp.

Saving Our Ancient Forests, by The Wilderness Society. Los Angeles: Living Planet Press, 1991. 116 pp.

Saving the Tropical Forests, by Judith Gradwohl. Washington, DC: Island Press, 1988. 214 pp.

Secrets of the Old-Growth Forest, by David Kelly. Salt Lake City: Gibbs-Smith, 1988. 99 pp.

Trees of Life, by Kenton Miller and Laura Tangley, Boston: Beacon Press, 1991. (A World Resources Institute book.) 218 pp.

FACT SHEET:

Where Will All the Forests Go?, ZPG*

AUDIOVISUAL AIDS:

Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG:

Banking On Disaster, 78 min. (video), 1988. Produced by Adrian Cowell.

The Development Road, 12 min. (video), 1991. Produced by Adrian Cowell.

The Rainforest, 10 min. (video), 1991. Produced by Adrian Cowell.

Our Threatened Heritage, 19 min. (video), 1988. Available from The National Wildlife Federation, 1400 16th Street, NW, Washington, DC 20036; 800/432-6564 (Film No. 58829).

Available from the Video Project, 5332 College Avenue, Suite 101, Oakland, CA 94618; 415/655-9050:

The Forest Through the Trees, 58 min. (video), 1990. Produced by Frank Green, Isan Film Group.

Rainforests: Proving Their Worth, 31 min. (video), 1990. Produced by Interlock Media Associates.

FOOD AND HUNGER

BOOKS:

Diet for a Small Planet, by Frances Moore Lappé. New York: Ballantine Books, 1987. 496 pp.

Hunger In America, by the Physician Task Force on Hunger in America. Middletown, CT: Wesleyan University Press, 1985. 231 pp.

The Hunger Road, by John Christopher Fine. New York: Atheneum, 1988. 148 pp.

Soil and Survival: Land Stewardship and the Future of American Agriculture, by Joe Paddock, et. al. San Francisco: Sierra Club Books, 1986. 217 pp.

State of the World's Children, by the United Nations Children's Fund (UNICEF). New York: Oxford University Press. This is an annual publication.

FACT SHEETS:

Harvesting Hope, ZPG*

AUDIOVISUAL AIDS:

Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG:

Growing Pains, 26 min. (video), 1988. Produced by The Conservation Foundation.

On American Soil, 28 min. (16mm and video), 1985. Produced by The Conservation Foundation.

Wheat Today, What Tomorrow?, 32 min. (video), 1988. Produced by Barrie Oldfield.

Famine and Chronic, Persistent Hunger: A Life and Death Distinction, 11 min. (video), 1989. Produced by and available from The Hunger Project, 1388 Sutter Street, San Francisco, CA 94109; 415/928-8700.

World Hunger: Current Issues Series, 30 min. (video), 1988. Produced by and available from The Close Up Foundation, 44 Canal Center Plaza, Alexandria, VA 22314; 703/706-3300.

WASTE DISPOSAL

BOOKS:

Natural Systems For Waste Management and Treatment, by Sherwood Reed, et. al. New York: McGraw-Hill, 1988. 308 pp.

The Problem of Waste Disposal, edited by Robert Emmet Long. New York: H.W. Wilson Company, 1989. 213 pp.

Rush to Burn: Solving America's Garbage Crisis?, by Newsday. Washington, DC: Island Press, 1989. 274 pp.

War on Waste: Can America Win its Battle With Garbage?, by Louis Blumberg and Robert Gottlieb. Washington, DC: Island Press, 1989. 301 pp.

Wasting Away, by Kevin Lynch. San Francisco: Sierra Club Books, 1990. 267 pp.

FACT SHEET:

More People, More Trash Turn Nation to Recycling, ZPG*

PERIODICAL:

Garbage: The Practical Journal for the Environment, Old House Journal Corporation, 439 9th Street, Brooklyn, NY 11215; 718/788-1700.

AUDIOVISUAL AIDS:

We All Live Downstream, 30 min. (video), 1990. Produced by A.C. Warden and Karen Hirsch. Available from The Video Project, 5332 College Avenue, Suite 101, Oakland, CA 94618; 415/655-9050.

Waste, 29 min. (video), 1985. Produced by Lynn Corcoran. Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG.

America Recycles: Preserving Resources, 20 min. (video), 1990. Produced by American School Publishers. Available from Social Studies School Services, P.O. Box 802, Culver City, CA 90232-0802; 800/421-4246.

Produced by and available from Cornell University, Distribution Center, 7-8 Cornell Business and Technology Park, Ithaca, NY 14850; 607/255-2092:

Recycling In Your School Makes Good Sense, 7 min. (slides and cassette), 1990.

Recycling Within Reach, 13 min. (video), 1990.

Wastewise, 19 min. (slides and cassette), 1988.

WILDLIFE ENDANGERMENT

BOOKS:

Biodiversity, edited by E.O. Wilson. Washington, DC: National Academy Press, 1988. 282 pp.

Dying Planet: The Extinction of Species, by John Erickson. Blue Ridge Summit, PA: Tab Books, 1991. 188 pp.

The Last Extinction, edited by Les Kaufman and Kenneth Mallory. Cambridge, MA: MIT Press, 1986. 208 pp.

Extinction, Drs. Paul and Anne Ehrlich, New York: Random House, 1981. 306 pp.

Extinction, by Steven Stanley. New York: Scientific American Library, 1987. 242 pp.

Wildlife Extinction, by Charles Cadieux. Washington, DC: Stone Wall Press, Inc., 1991. 259 pp.

FACT SHEETS:

Wildlife Sends S.O.S.: Save Our Species, ZPG*

Unraveling The Tapestry of Life: Can We Mend Our Earth?, ZPG*

AUDIOVISUAL AIDS:

Available from The Video Project, 5332 College Avenue, Suite 101, Oakland, CA 94618; 415/655-9050:

Ancient Sea Turtles: The Last Voyage?, 25 min. (video), 1991. Produced by Steve Cowan.

Conserving America: Champions of Wildlife, 58 min. (video), 1990. Produced by WQED in association with The National Wildlife Federation.

Where Have All the Dolphins Gone?, 58 min. (video), updated 1991. Produced by NTV.

The Great Gene Robbery, 26 min. (video), 1988. Produced by George Courtice for Tyne Tees Television. Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG.

ENERGY ISSUES

BOOKS:

Energy and Conservation, edited by Robert Emmet Long. New York: H.W. Wilson, 1989. 180 pp.

Energy Choices for the Future, by Barbara Fogel. New York: F. Watts, 1985. 103 pp.

The Reckoning, by David Halberstam. New York: Morrow, 1986. 752 pp.

The World After Oil, by Bruce Nussbaum. New York: Simon & Schuster, 1983. 319 pp.

FACT SHEETS:

Running on Reserve: Meeting the Energy Needs of the Future, ZPG*

Bumper to Bumper, Coast to Coast, ZPG*

AUDIOVISUAL AIDS:

Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG:

Energy Efficiency, 22 min. (16mm and VHS), 1986. Produced by Public Policy Productions for WNET.

Energy Supply, 34 min. (video), 1986. Produced by Public Policy Productions for WNET.

Running Out of Steam, 26 min. (video), 1988. Produced by George Courtice for Tyne Tees Television.

Energy: The Nuclear Alternative, 22 min. film, 1980. Produced by Churchill Films. Available from University of Illinois Film Center, 1325 South Oak Street, Champaign, IL 61820 (Film No. 54492); 217/333-1360.

Natural Resources—Future Quest, 33 min. video, 1991. Produced by and available from Hawkhill Associates, Inc., 125 East Gilman Street, P.O. Box 1029, Madison, WI 53701-1094; 800/422-4295.

MISCELLANEOUS:

Energy, Technology, and Society, An energy education package including a video (45 min.), a 300-page teacher's guide, and a software package. Contact Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG for more information.

POVERTY

BOOKS:

The Developing World: An Introduction, by E.S. Simpson. Essex, England: Longman Scientific and Technical, 1987. 360 pp.

World Development Report, by The World Bank. New York: Oxford University Press. This is an annual publication and can be ordered from The World Bank, 300 Raritan Center Parkway, Edison, NJ 08818-7816; 908/225-2165.

World Economic Data: A Compendium of Current Economic Data for All Countries in the World, by ABC-CLIO, 1989. Available from Social Studies School Service, P.O. Box 802, Culver City, CA 90232-0802; 800/421-4246.

AUDIOVISUAL AIDS:

Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG:

Dialogue on International Development, 20 min. (film and video), 1989. Produced by Aspire Films in association with Triune Productions.

Growing Up in the World Next Door, 59 min. (film and video), 1989. Produced by Asterisk Productions.

Population Change and Economic Development, 25 min. (video), 1987. Produced by and available from The World Bank, 300 Raritan Center Parkway, Edison, NJ 08818-7816; 908/225-2165 (Order No. 0-1920484-0).

World Poverty and Foreign Aid, 59 min. (video), 1987. Produced by The Close Up Foundation. Available from the Social Studies School Service, P.O. Box 802, Culver City, CA 90232-0802; 800/421-4246.

WALL CHART:

The International Human Suffering Index, 1987. Available from Population Crisis Committee, 1120 19th Street, NW, Suite 550, Washington, DC 20036; 202/659-1833.

POPULATION AND ECONOMICS

BOOKS:

For the Common Good, by Herman Daly and John Cobb. Boston: Beacon Press, 1989. 482 pp.

Future Wealth, by James Robertson. New York: The Bootstrap Press, 1990. 178 pp.

Our Common Future, by the World Commission on Environment and Development. New York: Oxford University Press, 1987. 383 pp.

The Politics of the Solar Age: Alternatives to Economics, by Hazel Henderson. Indianapolis: Knowledge Systems, Inc., 1988. 433 pp.

Steady-State Economics, by Herman Daly. Washington, DC: Island Press, 1991. 300 pp.

FACT SHEET:

Economics as if the Earth Really Mattered, ZPG*

AUDIOVISUAL AIDS:

Available from Bullfrog Films, Inc., Oley, PA 19547; 800/543-FROG:

Creating Alternative Futures, a series of 12 programs, each 30 min. (video), 1985. Produced by Hazel Henderson.

Small is Beautiful: Impressions of Fritz Schumacher, 28 min. (video), 1981. Produced by The National Film Board of Canada.

SOFTWARE:

Simplicon: Simulation of Political and Economic Development, by Cross Cultural Software. Available for Apple computers from Social Studies School Service, P.O. Box 802, Culver City, CA 90232-0802; 800/421-4246.

STATUS OF WOMEN

BOOKS:

If Women Counted, by Marilyn Waring. New York: Harper and Row, 1988. 386 pp.

May You Be the Mother of a Hundred Sons, by Elisabeth Bumiller. New York: Random House, 1990. 306 pp.

Women. . . A World Survey, by Ruth Leger Sevard. Washington, DC: World Priorities, 1985. 44 pp.

Women in the World: An International Atlas, by Joni Seager and Ann Olson. New York: Simon & Schuster, 1986. 128 pp.

Women, Poverty, and Progress in the Third World, by Mayra Buvinic and Sally Yudelman. New York: Foreign Policy Association, 1989. 64 pp.

FACT SHEET:

The Invisible Woman, ZPG*

AUDIOVISUAL AIDS:

Speaking Our Peace, 55 min. (film and video), 1986. Produced by Studio D, The National Film Board of Canada. Available from Bullfrog Films, Oley, PA 19547; 800/543-FROG.

Small Happiness, 30 min. (film and video), 1984. Produced by Long Bow Group. Available from New Day Films, 121 West 27th Street, Suite 902, New York, NY 10001; 212/645-8210.

WALL CHART:

Country Rankings of the Status of Women: Poor, Powerless and Pregnant, 1988. Available from the Population Crisis Committee, 1120 19th Street, NW, Suite 550, Washington, DC 20036; 202/659-1833.

GENERAL RESOURCES

Opposing Viewpoints, by Greenhaven Press, Inc. This series of books gives an even-handed look at a wide range of topics, such as immigration, global resources, the homeless, the Third World and social justice. The books draw from many sources to create a comprehensive view of each subject. Each issue is also divided into subtopics, which can be ordered separately in pamphlet form. For a catalog, contact Greenhaven Press, Inc., P.O. Box 289009, San Diego, CA 92198-0009; 800/231-5163.

State of the World, by Lester Brown, et. al., of Worldwatch Institute (New York: W.W. Norton and Company). This annual publication provides informative, readable reports on the important issues affecting our planet. The books are divided into sections, each of which addresses an environmental or social problem and offers constructive solutions. Worldwatch also publishes *World Watch* magazine and a series of *Worldwatch Papers,* which expand on issues presented in the magazine and books. All of these resources can be ordered from Worldwatch Institute, 1776 Massachusetts Avenue, NW, Washington, DC 20036; 202/452-1999.

World Resources, by the World Resources Institute (New York: Oxford University Press). Published semi-annually, this book provides reliable, up-to-date figures on our natural resources and environmental problems. *World Resources* offers an overview of various topics, reports on basic conditions and trends and provides a wealth of data in the form of charts and tables. Additional data can be found in their *Environmental Data Report,* published in alternating years with *World Resources.* For more information, contact World Resources Institute, 1709 New York Avenue, NW, Washington, DC 20006; 202/638-6300.

* Single copies available free upon request from Zero Population Growth, 1400 16th Street, NW, Suite 320, Washington, DC 20036; 202/332-2200.

ZPG Population Education Materials

Earth Matters: Studies for Our Global Future (for grades 9-12)

ZPG's newest teaching kit! This spiral-bound book of 12 student readings and 32 innovative activities covers such topics as deforestation, global warming, hunger, poverty and the status of women. *Earth Matters* also examines the underlying clashes between economic growth and environmental health. Activities include simulations, debates, lab experiments, critical thinking exercises, problem-solving challenges and a rainforest board game. #EMTT $19.95.

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EdVentures in Population Education (for grades 4-12)

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Elementary Population Activities Kit (for grades K-6)

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Bring home the relevance of population studies by inviting students to discover what is happening in the USA! This kit is based on and includes ZPG's 1988 reference book, *USA by Numbers,* compiling current and historic data on U.S. demographic, socioeconomic and environmental trends from A(acid rain) to Z(zero population growth). Fourteen classroom activity modules guide your students through analysis of this fascinating collection of information. #USAT $19.95.

Kenya: A Country in Transition (for grades 9-12)

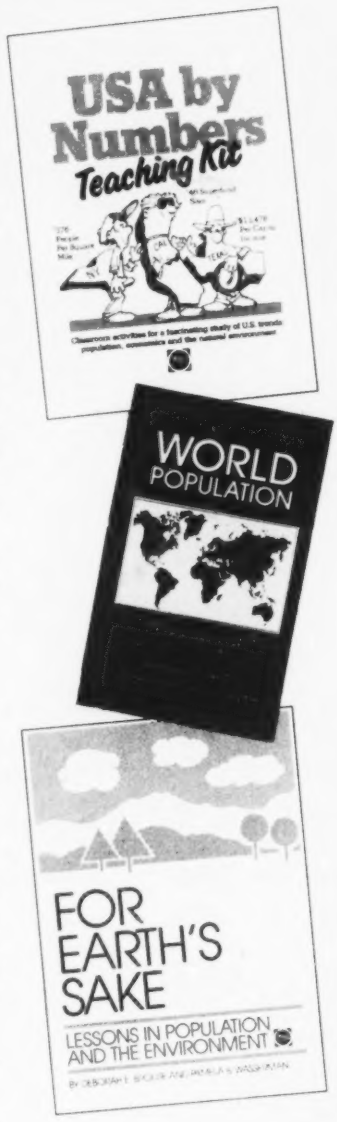
Kenya, the world's fastest-growing country, is anticipating a doubling of its population of 25 million in just 18 years. This teaching unit explores virtually every aspect of the effects of rapid population growth; demographic transition, the effects of modernization, ecological and social transition, signs of progress and a look at the country's future are all included. The unit comes with 11 eight-page illustrated student handouts and a teacher's guide offering discussion questions and hands-on activities to follow up on the reading material. #KNY1 $9.95.

"World Population" Video (for all grade levels)

This international award winning video presents the best-ever graphic simulation of human population growth! In this six-minute video, as time passes, dots are placed on a world map to represent millions of people added to the population. Historic references in this edition place population changes in context. A striking depiction of actual population growth from 1 A.D. to the present and projected future growth to the year 2020. VHS Videocassette. #WPPV $29.95.

Computer Software for Population Education (for all grade levels)

ZPG's new, comprehensive review helps teachers find the programs most suited to their needs. Nearly 40 software programs for all grade levels are reviewed, including mathematical models, simulations, databases and problem-solving games. Each review includes price and ordering information, as well as hardware compatibility for each software package. #PPSF $1.95.



Teaching Population: Which Textbook to Choose? (for grades 7-12)

Learn which science textbooks provide adequate coverage of population dynamics and impacts in ZPG's new report. Survey of 44 current editions of life science, biology, and environmental science textbooks from 17 different publishers. Each textbook is rated on an easy-to-read matrix which indicates how the book addresses general population information, projections for the future and the link between population growth, resource depletion and environmental quality. #TEXT FREE.

Actividades para Educación sobre Población (for all grades)

To meet the needs of classrooms in Latin America and bilingual classes in the U.S., ZPG offers seven of its most popular teaching activities translated into Spanish. The motivational activities include simulations, games, problem-solving challenges, a quiz, riddles and a discussion guide to ZPG's dramatic video, *World Population*. #SPAN FREE.

Teacher's PET Term Paper (for all grades)

Lively quarterly newsletter for teachers involved in K-12 population education. Features student activities, and reviews of books, audiovisuals, software and curricula. #TCHR $3.00 for one-year subscription.

Readings on Overpopulation (for grades 6-12)

This collection of recent ZPG articles examines the various aspects of continued population growth. Topics include: traffic congestion, loss of forests and wildlife, the garbage crisis, global warming and food shortages. #ENVR FREE.

ZPG Population Education Training Workshops for Teachers

ZPG offers population education training workshops through inservice programs and teacher education programs throughout the country. Since 1975, thousands of educators have participated in these workshops, and hundreds of thousands of young people have benefited from population studies as a result.

Population education helps students appreciate the interdependence of people, animals, natural resources, food, industry and land. They learn not only about the social, political and environmental impacts of population growth and change, but more importantly, how their own personal decisions will affect the quality of life in tomorrow's world.

ZPG workshops present current information on world and U.S. population trends and their impacts and demonstrate a variety of teaching strategies designed to actively involve students in the learning process: films, games, quizzes, simulations and other thought-provoking exercises. Workshop participants receive complimentary teaching materials to support their population education efforts: current population statistics, scripts for classroom activities, resource lists and reference guides. They also receive follow-up assistance through a quarterly newsletter, phone contacts and correspondence.

Workshop length and content are tailored to the professional needs of the participants. Some are as short as an hour, others as long as a full day. Some are geared toward a specific audience, e.g., high school social studies educators, middle school life science teachers or elementary school teachers; others are open to teachers of all subjects in grades K-12.

Because ZPG is a nonprofit organization with a limited budget, we ask education agencies sponsoring our workshops to cover travel expenses and provide a modest honorarium. For further information, or to arrange a ZPG population education workshop, contact:

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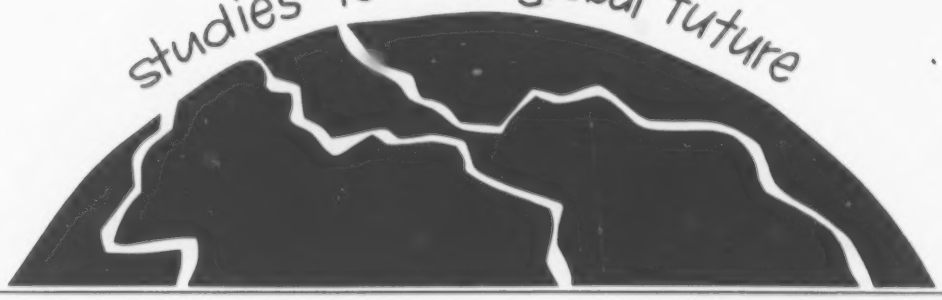

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